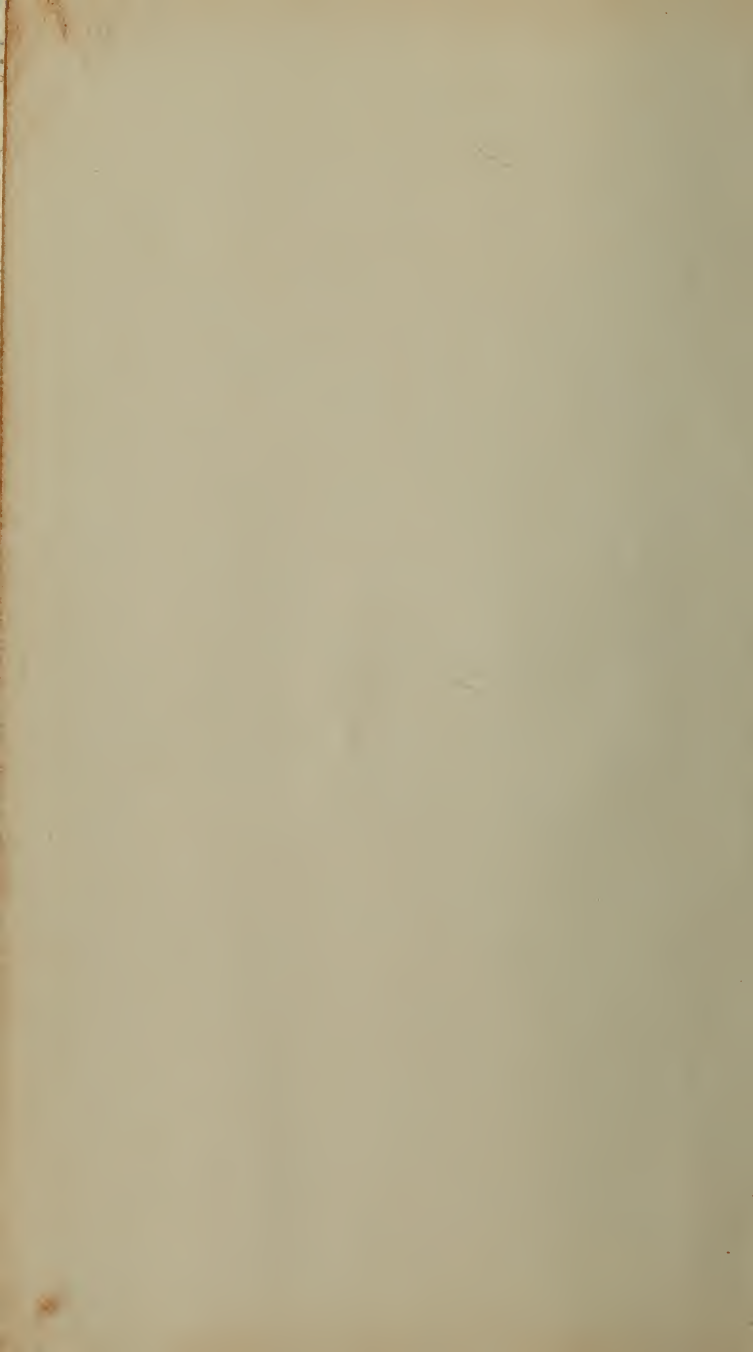







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NATURE.



THE EARTH

And its Wonders.

IN

7977

A SERIES OF FAMILIAR SKETCHES.

BY

CHARLES ADAMS, D. D.

"I meditate on all thy works."—PSALM CXLIII, 5.



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Dedication.

WILLIAM H. ALLEN, LL. D.,

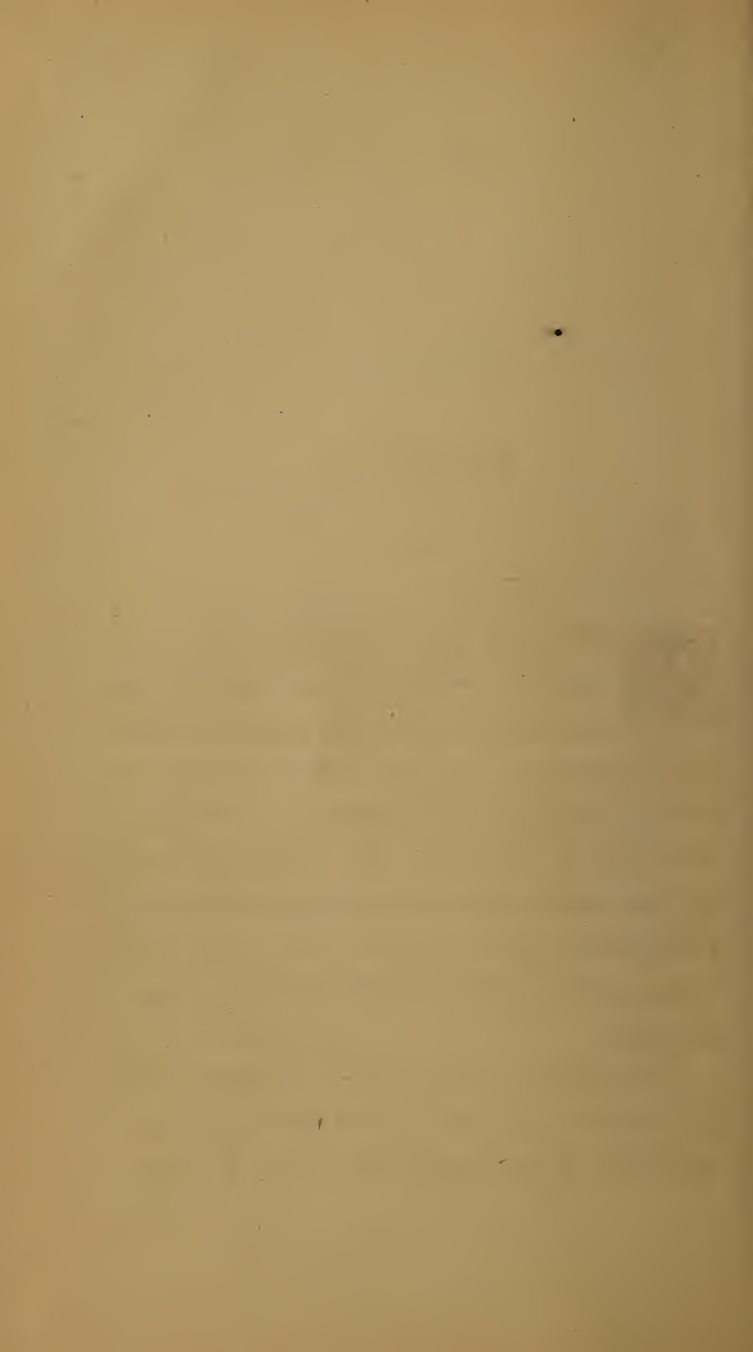
President of Girard College.

MY FRIEND AND CLASSMATE:

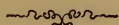
TWO reasons have specially prompted me to place your name in this little volume. One is the fact that you have so long and so successfully devoted your eminent abilities to the education and welfare of youth—a work in harmony with the genius of this my humble effort; and another reason is founded upon those invariably pleasant relations, and that sincere friendship, which commenced with our college days, and upon which time and separation have, as I trust, exerted no disturbing influence.

With profound and affectionate respect,

Charles Adams.



Introduction.



THIS book aims to present to young readers, in a familiar style and orderly arrangement, the more prominent natural phenomena of the earth. It lays no claim to being profound, learned, or original; while yet it endeavors, by lucid statement and appropriate illustration, to attract special attention to many matters which, from their commonness, are too apt to be but slightly appreciated.

The natural world is full of marvels; but to the few only, it is to be feared, do these wondrous things come home with a proper

realization, and the great multitude pass on blindfold through this scene of enchantment, their minds and hearts never opening to the charms and wonders wherewith the God of nature hath furnished and adorned this beautiful world.

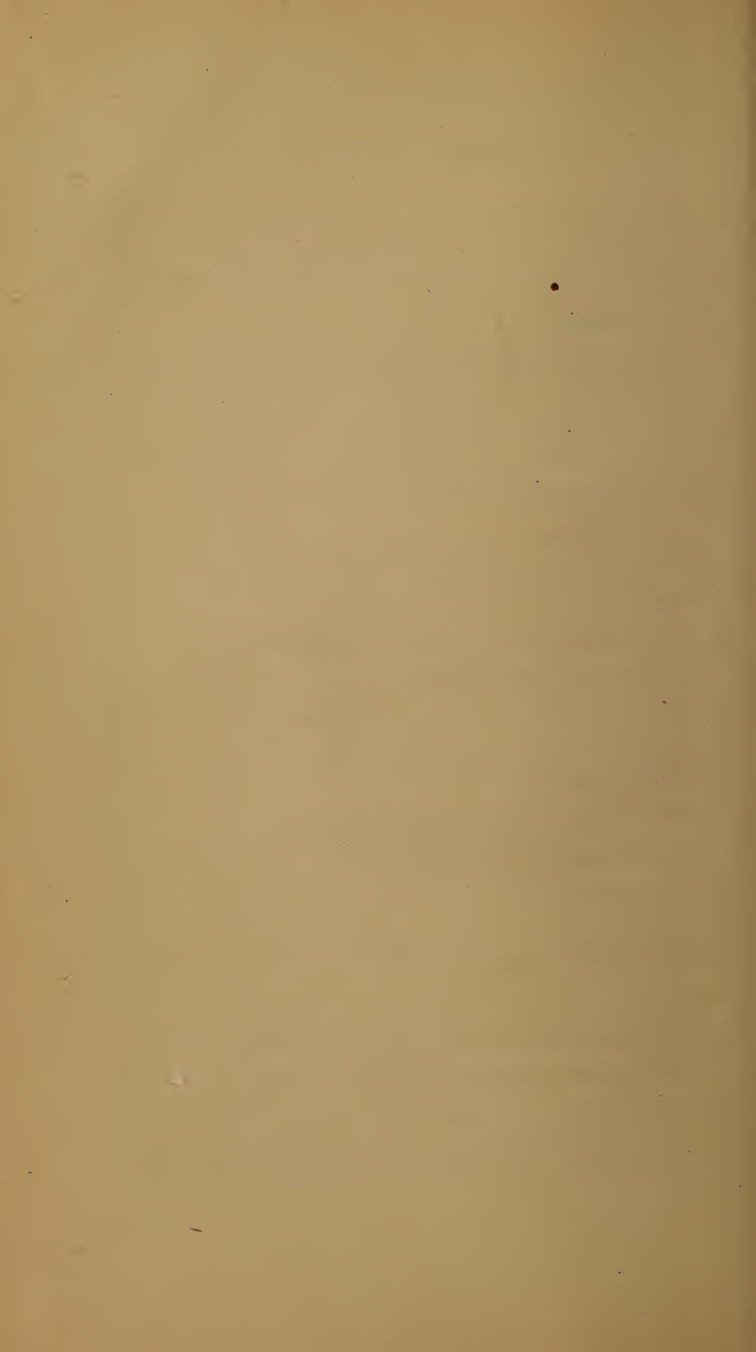
Happy the writer whose magical pen should so touch these concealed glories as to cause them to flash vividly before the startled eye, and thus constrain the dullness and blindness of millions to give place to a clear and perfect vision! "Open his eyes that he may see!" prayed the solemn prophet in behalf of his mystified and confused servant. And when the prayer was heard, and the scales fell, and he saw clearly, behold, the mountain was full of horses and chariots of fire round about Elisha!

This opening of eyes, this purifying of the vision, is one of the world's great necessities. God is all around us, his marvelous working is every-where. Nature is but his outbeaming,

and at every motion of ours we touch his goodness, and are ever stepping to the music of his boundless beneficence.

It is sad, then, that we should tread heedlessly, when to move along this world carefully and wakefully is to keep company with God and walk in paradise.





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The Earth and its Wonders.

Salutatory.

Y YOUNG FRIENDS,—It has occurred to me to prepare specially for you a series of familiar sketches, touching some of the works of God which we see on this earth. The Scriptures declare “Great and marvelous are thy works, Lord God Almighty: in wisdom hast thou made them all.”

These great and marvelous works are all around us. Many of them we see, and very many others are more or less concealed from us. And then, again, many of these works which we see every day are but partially known to us. We do not notice and study

them as we ought, nor do we sufficiently connect them with the great Hand that created them. Thus we are prone too much to contemplate the works of Nature as we do those of Art—that is, we confine our attention to the *work itself*, with but little thought of its Maker or Author.

Now, we should never for a moment forget that what we call the “works of Nature,” are nothing less than the works of God; and if there is such an arrangement as that which we call *Nature*, God himself has established this arrangement, and he upholds it forever.

These works of Nature, or, more properly, of the God of Nature, are of exceeding interest to all who examine and study them in the proper manner, and with the proper spirit. They are, indeed, one of the means by which God manifests himself to us. They are one of his grand revelations. They tell us, as plainly as words can tell us, of God’s greatness, of his wonderful power, skill, wisdom, benevolence, and love. Words could *tell* us of all these, but the works of God *illustrate* them—show them, and that, too, most clearly and convincingly.

And then how interesting to a good youth of either sex, or to any good person, is the study of the Creator's works! We are all apt to feel the less interest here from the fact that we are so familiar with many of these works. We have always seen them, and had some acquaintance with them. They have been, as it were, our companions from the beginning of our lives, and we come to look upon them as things of course, and as we look upon our own hands or feet. They are, so to speak, old to us, and yet all young people should keep in mind that there is much about these old things that would be new to us—much that has never yet entered into our thoughts. And these new ideas about these old things are, many of them, such as would interest us greatly, and would even present them as new and wonderful.

Let my young friends suppose it possible for them to be transported to the moon, where every thing would be actually new to them. With what intense interest and curiosity would they light down upon that strange world! How eagerly would they notice every thing! How interesting every step would be! And

if there were beings, or mountains, and vales, and rivers there, how clearly would every object be mapped upon their minds! But the earth where we are is at least as wonderful as the moon, and there are, doubtless, as many curious things here to interest, and things, too, as new to us as any object or fact connected with the moon.

Come, then, my friends, and contemplate with me this great earth of ours. Let us walk over it together, and notice a great many things that may be both old and new to us; let us seek out the less familiar things, and we may be assured that if our eyes are open, and we look and consider attentively, we shall be not only instructed and interested, but we shall be rendered happier and better amid these pleasant walks of ours.

It is true, I shall be a stranger to most of you, and our rambles will not be to you as if with a father or mother, or some other one known and loved by you. And yet I may promise you that it shall be a friend whom you are to accompany—a friend, too, of your parents, some of whom were my pupils in their own bright morning days of life, and

used to roam with me amid some of these same interesting scenes before you had yet begun to be.

With the kindest remembrances of these fathers and mothers, and with the most respectful regard for those of your parents whom I have never seen, as well as with the most ardent wishes for your own best welfare, I subscribe myself, my dear young friends,

Yours, most truly and affectionately,

2

C. ADAMS.



The Earth.



THIS earth is to be the subject of our contemplations in these Sketches, let us first glance at it as a whole.

The earth, as you are aware, has the appearance of a vast plain or level, in the center of which we seem to be living and acting. Overhead is the sky or firmament, which, in the language of Dr. Chalmers, "presents an immense concave resting down upon the circular boundary of the world." This is the appearance; and we can well remember when we thought it was precisely so. To our eye and imagination the earth was the great plain just noticed, spread all around us as a mighty wheel; and on the circumference of this wheel came down the sky, closing in the great round

world in every direction. And no wonder if it occurred to us more than once, in those sweet days of childhood, that, on some bright and sunny afternoon, we would take a tramp across the intervening fields and pastures, and see how it looked where that solid and beautiful sky came down to meet the underlying and substantial earth! Such was one of the delusive imaginings of our life's early morning; and if, as we grow older and wiser, it may excite a smile, it may be useful for us to remember that many other dreams are still lingering with us, which, however, are equally delusive and baseless.

On what foundation this great circular earth was resting while the sky was reposing with all its weight upon the huge circumference, came not, perhaps, into our little minds to inquire. This was a question, however, which seems to have bothered many older minds in darker ages of the world's history; and many a childish theory was invented touching this same mysterious foundation. Some dreamed that the great and far-reaching plain rested upon the shoulders of a huge giant standing beneath; or on the back of a tremendous ser-

pent; or some other support of enormous strength. But none of the inventors of these curious theories have ever explained to us the foundation on which rested the feet of the giant himself, or the belly of the awful serpent. Happy for us, when little children, that none of these vexatious questions, or theories, ever came into mind. It was enough for us that all beneath our little feet was solid and firm, and that not the shadow of a suspicion arose to trouble us as to the question of our perfect security. With us it was as if we heard and understood that great voice telling of Him "who laid the foundation of the earth that it should not be removed forever."

And right here, perhaps, some bright boy or girl who have read their Bibles and have noticed such passages as I have just quoted, will inquire why the Bible itself should speak of the earth as it looks, as if it were indeed flat and circular, and rested upon some underlying foundations.

This is a reasonable inquiry, and we answer it by saying, first, that the Bible was designed to instruct all classes of people, the ignorant as well as the learned; secondly, it was not

designed to teach science, but religion, and religious truth and duty. Hence, thirdly, the Bible is neither arranged scientifically, nor in its allusions to the heavens and earth does it speak of them in such a style or manner as accords with scientific exactness, but, rather, as these things *appear* to our vision. Thus the Bible, as above, speaks of the earth as having foundation ; as if it were erected upon something, as a house. Science, on the other hand, treats of the earth in this respect, as it really is, and not as it seems to be. The Bible speaks of the "ends of the earth," as if there were really such "ends." Science instructs us that, in fact, the earth has no ends. The Bible alludes to the sun just as it appears to our vision, as rising and setting. But science places it as central and stationary so far as it relates to the earth. The Bible speaks of the stars according to their appearance. Science treats of them as they actually are, and at an infinite remove from the aspect they present to the eye.

II.

The Earth's Shape.



IF the earth which we inhabit is not flat, as the ancients suppose, and as many even of its present inhabitants believe, what is its actual shape? As you have already learned, the earth is *globular*. It is not, indeed, a perfect globe, but so nearly so that were we to see an exact model of its shape, the eye would discern no difference between it and a perfect sphere. It is slightly flattened at the poles, as if you should take between your two hands an orange perfectly globular, and thus apply to it the slightest pressure. Then the diameter from one hand to the other would be an atom less than another diameter across this one at right angles to it. This difference between the two diame-

ters thus represented, is about twenty-six miles. This, though considerable of itself, is, however, a very small quantity when compared to nearly eight thousand miles, the length of the earth's diameter; and the proportion of the two diameters is thus exactly as three hundred and one to three hundred and two. It is not necessary to suppose that this was the exact shape of the earth when first created, or that this shape was otherwise than a perfect sphere; for, had it been such at the beginning, its swift and constant motion, in entirely revolving upon its axis every twenty-four hours, would naturally and gradually tend to withdraw the material of the earth from the poles toward the equator, thus forming a slight protuberance in the equatorial regions at the expense of the polar regions.

The process may be well illustrated by imagining a knitting-needle thrust, at the stem, directly through an orange; the two ends of the needle would represent the north and south poles of the earth. Now, immerse the orange in a vessel of oil, and then whirl it rapidly on the needle as its axis, and mark the result. The oil will be measurably drawn away from

around the needle at either end, and slightly heaped up on the part of the orange which is equidistant from the two poles, that is, upon the equator.

In the first chapter of the Bible, where we read the Mosaic account of the creation of our earth as it now appears, we have the globe represented as previously being entirely covered with water. If, as is quite probable, it was then, and afterward, revolving upon its axis, the phenomenon above noticed, of the diminishing of the polar substance and a corresponding accumulation at and around the equator, would have been a certain consequence.

Our earth, then, is of globular shape, notwithstanding it has the seeming of a vast plain; and it will not be difficult for you to comprehend why it has this appearance. It is because of its prodigious extent. Were we to stand on a great ball of a mile in diameter, and three miles around it, we should not seem as now to be standing upon a plain, but, looking hither and thither, we should observe the surface of the ball gradually curving downward in every direction from the point where we might be standing, while, at the distance of a


quarter of a mile, more or less, the surface would sink entirely from our sight.

Not at all so, however, as we stand on this immense ball which we call the earth. Here, on whatever plain or ocean we may be, there is no perceptible curvature downward within the reach of our vision, and hence, wherever we may walk or sail, the aspect is that of an immense plain, varied on the open sea by nothing, and interrupted on the land only by hills or forest, as it stretches away to the far horizon.



III.

Earth's Shape Illustrated.

OME of you may not as yet have clearly understood how it is ascertained that our world is a globe, since it has scarcely any appearance of being such. There are several very clear and conclusive proofs of this great fact. Let us, in the first place, undertake a long imaginary journey, and as this our journey is to be imaginary, we will start from where we please, and take just the direction we please. The city of Washington, then, shall be our point of departure, and precisely west shall be our direction. Of course we shall go on this line sheer across the continent, and come, some day, to San Francisco. Here, taking one of the steamships now constantly plying the great Pacific Ocean, we will

continue our course due west, and come in about twenty days to Jeddo, in Japan. Thence, still going due west, we will take passage across the Japan and Yellow seas, and starting from Pekin, in China, we will continue our far western way over Asia and the Hellespont to Constantinople; whence, by land and sea, still westward we will reach Lisbon, in Portugal; where, embarking with our prow exactly west, we will cross the Atlantic, and, landing at the mouth of Delaware Bay, and proceeding overland, we will come to Washington again, the place of starting on this long, long journey. We have gone from Washington, on a due western course, 25,000 miles, and, instead of being all that distance away from the city, we are at it again. We went out from the western side, and, without changing our course, we have come to the eastern side of the same city—that is, we have gone round the world from Washington to Washington.

And now perhaps some one will answer me that I have proved the world to be round in an eastern and western direction, but this does not prove it to be so on a northern and south-

ern line ; and it has never been sailed around by way of the North and South Poles, and probably never can be. Well, then, let us adopt another criterion. If we can not by reason of ice and cold go to the poles and pass beyond them, let us, in our second journey, go as far as possible. We will select the same starting place, the city of Washington, and lay our course, this time, due north instead of west. The latitude of Washington is very nearly 39° , and before starting we will direct our eyes exactly to the northern horizon, and then elevate them the same number of degrees, 39° , and note a little star lying there, called the North Star.

We will take with us a little instrument adapted to the purpose of noting the height of the stars above the horizon. Starting on our due northerly course, we presently reach Montreal, in Canada ; and then, with our instrument, we ascertain that our North Star, instead of remaining at 39° , as when we started, has somehow lifted itself up full six degrees, and stands at 45° . How is this ? Continuing our journey nearly seven hundred miles north from Montreal, and again sighting

our guiding star, lo, it has ascended ten degrees further up toward the zenith. How can this be true of a star that we thought was always stationary? Only thus: it is not that our star has gone upward, but that we, in coming a thousand miles from Washington, have been all the time going downward. For had we been traveling upon a horizontal plane all along this northern tour, the star which, at Washington, was only 39° high, would still remain at the same elevation. But we have been traveling on an *arc*, instead of a straight line, and as on this arc we have gone downward under the star, the latter, by the same amount exactly, has gone upward. And should we go on to the pole itself, the North Star will stand directly overhead.

This means that the path from Washington to the North Pole is an *arc*; and the same is true of a path to the pole from any other point. That is, the north and south of the earth are globular as well as the east and west; and this means that the whole is globular.

IV.

Earth's Shape Further Illustrated.



HERE is another consideration as much or more convincing, going to show that our earth is globular instead of being flat, cylindrical, or of any other shape. We refer to eclipses of the moon. You have doubtless learned that these eclipses are caused by the earth passing directly between the sun and moon, so that the huge shadow of the earth, projected out into space, hits the moon. And if the three centers, namely, those of the sun, moon, and earth, are in a straight line, when the earth falls between the sun and the moon, the latter will be wholly obscured by the earth's shadow, and continue so for two or three hours. On the other hand, if, in making the passage between the two

luminaries, the earth fails to pass precisely between them, but its center rises a little above or falls a little below, the straight line joining the other two centers, then the earth's shadow will strike only a part of the moon, and it will, consequently, be but partly eclipsed. Now this shadow of the earth on the moon, when the latter is eclipsed, is always and invariably *circular*. It never has a straight side, never has an angle, never is a mere line across the moon's face, never is concave, never any other shape than exactly circular and convex. And what is the shape of that object that, in any and all directions in which you can place it, forever casts such a shadow? To this question there is but one answer. It is a globe, and can be nothing else.

Other considerations might be adduced leading to the same conclusion ; but these are sufficient, and we may settle it in our minds as absolutely certain that the earth which we, for the present, inhabit, is a great globe or ball hanging in the mid heavens. It is also an undoubted fact that the heavenly bodies around us, the sun itself, the moon, the planets, and all the stars of the firmament, are of similar

shape. Some of these approach nearer the form of a perfect sphere, some others not so near ; but the globular shape, more or less perfect, they all doubtless possess.

Why the great and all-wise Creator has given to ours and other worlds this characteristic shape is probably but partially known to us. But that there were very important and sufficient reasons for this we may be fully assured. He does nothing in vain, or capriciously, or wantonly, and without ample reasons ; and though we, with all our eager penetration, can see but a part of His ways, a very small part, yet a reason or two for the sphericity, or globular shape of the worlds, may not be beyond the perception of mortals.

These great worlds, and ours with the rest, though apparently so stationary and still, are *in motion* ; and this motion is a flight through space so swift and awful as to be utterly and immeasurably beyond every human conception. And it is very likely, if not quite certain, that the globular shape is best adapted, if not indispensable, to the regularity and safety of such motion. Then, as to our globe, it is certain that this "round

world" is far better adapted to its purposes, especially to the convenience, comfort, and even the safety, of animal nature, than any other conceivable form. To suppose the earth to have had given to it a cubical figure would be to suppose the greatest part of it uninhabitable. At least two out of the six sides would doubtless have been as desolate as the polar regions of the globe now are, while the eight corners would have projected themselves into space, a sort of pyramidal mountains, many leagues in height, the drear abode of everlasting snow, and storms, and whirlwinds, and utter desolation.

On the other hand, had the earth, instead of being a globe, been an immense plain as it actually appears to be, the present law of gravitation and the daily revolution upon its axis remaining as now, it is not easy to conceive how, not merely the animal creation, but the earth itself, could escape confusion and ruin.

The Earth's Dimensions.



OUR world, then, is a ball. This is easy to say or write, but who may ever portray, or even begin to imagine its prodigious dimensions? A simple process of mathematics will give us the measurements, and we can write down the figures that express these measurements, and we can look at the figures and ponder them, and essay to imagine what they actually express. But all in vain.

But let us glance a moment at the measurements. First, let my young friends form a clear idea of what is termed a great circle of the earth. It is a circle or circumference drawn around the earth in any direction, so as to divide it into two equal parts. Thus the equator is an example of a great circle. We

will suppose one of these great circles drawn around the earth at right angles to the equator, and, of course, passing through the North and South Poles. We call such a circle as this a *meridian*. We will now take a position on this meridian at 40° north latitude, and with our eye on the North Star, we will travel north until the star shall stand at 41° instead of 40° . As the star has ascended one degree, so we have traveled just one degree along the great circle. Here we will stop and travel back to the place of starting—measuring, as we go, the distance between the two points. Completing the measurement, we find the distance to be sixty-nine and one-half miles. This is the length of one degree of a great circle of the earth, by actual, careful, and exact measurement. Now, as in every circle there are 360 degrees, if we multiply this length of one degree by three hundred and sixty, we shall have the whole extent of the circle, 25,020 miles. This, then, is the maximum or greatest distance around this ball called earth. From this we deduce, by the ratio of the diameter and circumference of a circle, that the earth's diameter—its distance from one side, through

the center, to the opposite side—is about eight thousand miles.

But what human mind can form any conception of these tremendous measurements or distances? Sometimes in traveling we discern an elevation seeming far, very far away in the dim distance before us. By a great effort our minds can, perhaps, take in all the long path leading to that object. Yet it is a conception of only about thirty miles, and this long reach, that requires so positive an effort to conceive adequately, must be multiplied to eight hundred and thirty-three times in order to extend around this enormous globe. A train of cars flying a mile a minute would require seventeen days and a third of a day to traverse the amazing circuit.

Such is the circumference and such the diameter of this ball on which we dwell. And if you wish to proceed further, and ascertain the extent of its whole surface, you have only to find, first, the extent of the surface, or area of the great circle, which is obtained by multiplying its circumference, 25,000 miles, by half its radius or one-fourth of its diameter, 8,000 miles, and you have, in round numbers,

for the area of this great circle, 50,000,000 of square miles. Then, as multiplying the area of a great circle of a ball by four gives the area of its whole surface, you will thus have 200,000,000 of square miles as the measure of the earth's surface. Now if we wish to proceed a step further, and ascertain the solid contents of our world, the process is direct and simple. We have the surface in square miles, 200,000,000; we have the diameter in linear miles, 8,000. We have only then to multiply the surface by half the diameter, 4,000, and afterward divide the product by three, and we shall have the mass of our globe in solid miles. *How* this is so, you will ascertain by the study of geometry. So, by the above multiplying, we shall find the solid contents to be nearly 260,000,000,000 of cubic or solid miles. All this inconceivable mass is under your feet as you walk and play, and spreads itself afar before and behind you, and is the great theater of your present but transient dwelling-place.

VI.

Earth's Superficial Dimensions.



AM unwilling to dismiss this idea of the immensity of our earth without an attempt or two to illustrate further its inconceivable dimensions. And although all that may be said and written and pictured will never avail to lift our imaginations hardly a step toward the great result, yet it may serve to gratify an innocent and laudable curiosity to endeavor, by one and another contrivance or illustration, to approximate toward some feeble conception of the earth's magnitude.

Our preceding sketch, then, has proved the surface of this globe to comprise 200,000,000 of square miles. One square mile is an easy conception. In the Western land surveys, it

comprises what is termed a *section*, and contains six hundred and forty acres—a farm of large dimensions. If you have never seen such a square of land, yet you have in your minds the idea of a mile as it extends along the road that passes your home. From your house to a certain neighbor's is just about a mile, and you have often traveled it, and call up in your minds the whole path with its little turns, its trees, its ups and downs, and each intervening house and brook. You know what a mile is. So if there were a square plain inclosed by a fence along each of its four sides, and each of the four fences were a mile long, you could stand by one of these fences or over in the center of the great lot, where each fence would be a half mile distant, and thus receive into your mind a tolerably fair idea of the magnitude of one square mile. But if, instead of standing in the center of one square mile, you should stand in the center of a hundred of such, where each fence at its nearest point would be five miles off, and, of course, scarcely visible, your idea of this one hundred square miles would be very imperfect, while your comprehension of a thousand of such

would be entirely inadequate. What, then, of ten hundred thousand, or a million! What of this million multiplied two hundred fold! Yet this is the earth's great surface! Who can imagine it? Who can begin to do so?

Now let us return to our one square mile, of which we have so perfect an idea. We will cross it from one fence to the opposite fence. If we walk as fast as men usually walk when going to and from their business, we shall cross the lot in twenty minutes, and should cross three such lots in an hour, and, of course, thirty of them in ten hours, by which time we should be weary, and we should have walked far enough for the day, and would need to rest till to-morrow. Now if we should walk on at the same rate till we had regularly crossed every square mile of the earth's surface, we should be more than 18,000 years old before we finished the enormous tramp, and should we propose to be more particular, and so cross not only each square mile, but each acre of this vast landscape, at the same rate, we should be occupied ten hours every day through 12,000,000 of years.

Or should we propose for ourselves a more


CORAL REEFS.



speedy and superficial survey of this globe of ours, we will suppose ourselves accommodated with a comfortable seat about a mile aloft in the air, the seat to be stationary while the earth under us is turning eastward in its daily revolution. We will choose a position such that a belt of the surface five miles wide shall pass under us and by us, until in each twenty-four hours every such belt of five miles has been successively passed, and been inspected by us as it glided onward. Much of the earth, it is true, will rush beneath us with a velocity that will be frightful to contemplate—houses, trees, lakes, rivers, hills, and plains flying eastward with double the swiftness of a cannon-ball, and we shall need to be wide awake or our observations will be superficial indeed. Yet such an examination, comprising but the merest glance of a moment, will occupy us, in the swift and vast survey, every hour, minute, and second of more than eight long years.

VII.

Earth's Solid Dimensions.

FROM such calculations and imaginings let us venture a glance away from the surface of this great world, and endeavor to penetrate down amid the unfathomable recesses of its awful bulk. While the earth is globular in shape, it is not, like the artificial globes in the schools, a hollow and empty shell, but is a solid mass, with an average weight of about five times that of a globe of water of equal dimensions.

We have seen that while the earth's surface comprises 200,000,000 of square miles, its mass or bulk comprises 260,000,000,000 of cubic or solid miles. Here again, and here especially, we are lost, and all human ideas and computations are at fault and vain.

We have scarcely more conception of this stupendous mass of our earth than has a worm on the sides of Mont Blanc of that huge and awful eminence. Two hundred and sixty-seven thousand millions of solid miles! Suppose that, in our imagination, we take out one of these solid miles and set it up bodily and in shape on some wide-spread plain. What an object and what a wonder! A mile along, a mile through, a mile aloft! In vastitude what is comparable to it among all the works or erections of man?

The greatest of the Egyptian pyramids has a square base of seven hundred and forty six feet on a side, covering about thirteen acres, and was originally about five hundred feet in height, while the weight of this huge structure was seven and one-half millions of tons. And yet, to erect our supposed edifice of one solid mile would require fifteen hundred and twenty-five just such pyramids. Were the great pile hollow, and divided into stories each ten feet in height, and allowing a square yard for each person, it would contain within its walls more than 1,600,000,000 of people, or a third more than all the present inhabitants of the earth.


Look at it: on a favorable day it could be seen a hundred miles away. It is within a few hundred feet of the height of Mt. Washington, in New Hampshire. Place another solid mile upon the top of this, and you have the height of Mt. *Ætna*. Place still another upon the top of these, and there looms up the awful altitude of Mont Blanc, the loftiest mountain of Europe. And yet these are only three out of the 260,000,000,000 of just such enormous cubes. Now remove the two upper cubes and leave the first one as before. It is solid and comprises a certain amount of matter—such an amount as that to remove this one solid mile a distance of twenty miles would require, through seventy-five years, 100,000 men and 200,000 horses. Once more: were this globe of ours resting upon another globe precisely similar, its weight, in tons, pressing upon the other globe would be expressed by the number $5,842 \times 10^{18}$, that is, 5,842 multiplied by ten raised to the eighteenth power, that is, 5,842,000,000,000,000,000,000, or 5,842 millions of millions of millions of tons.

Of this almost infinite weight you and I, of course, know nothing. We have no conception

of even a single one million of all this countless number of millions. The great mathematician, Archimedes, once boasted that if he had a place to stand upon separate from the earth and independent of it, where he might arrange and apply his apparatus, he could move this vast globe. But some curious inquirer setting himself to investigate the matter, came to the conclusion that even were such a feat at all within the limits of possibility, some millions of years would be consumed in moving the globe to the amount of a single inch. How overwhelming, then, is the thought of that Omnipotent Being who can take up this immense world as a "very little thing;" who upholds it "by the word of his power;" who, in the beginning, hurled it away on its swift and everlasting flight around its central sun, and who causes it to perform an entire revolution upon its axis every twenty-four hours!

VIII.

The Earth's Motions.

HE closing remarks of my preceding sketch allude to the fact that this earth, so immeasurably large and heavy, and apparently so still and stationary, is, however, in motion. As suggested, it has two great and principal motions; one around the sun, and the other a rolling motion upon its axis, like the revolution of a top. Its motion around the sun is of terrible swiftness, and one of these revolutions makes our year. Being about 95,000,000 of miles from the sun, its circuit or orbit around it is more than six times that distance, or about 580,000,000 of miles. This would be 1,600,000 miles every day, about 67,000 miles an hour, and $18\frac{1}{2}$ miles every second.

Think of such an enormous world flying through space at so fearful a rate. Could we stand off somewhere a thousand miles from the earth and see it go by us at that distance, what an awfully magnificent spectacle would be presented to us ; and who could ever compute the force that drives the world through its great circuit forever ? Where resides that force ? Only with one Being in all the universe, and that same Being has us in his hands and sacred keeping from moment to moment, and can exert the same power for our loftiest happiness.

But while the earth is thus flying around the sun, and thus making our year, it has, at the same time, a rolling motion upon its axis, making our day of twenty-four hours. A top spinning upon the floor, and at the same time circling around the room, well illustrates this double motion of our earth. And while its motion around the sun, as we have just noticed, is so terribly swift, this motion upon its axis is much less so, but still of greater rapidity than that of any motion upon its surface ; for a ball like this great earth can not roll sheer over in twenty-four hours without a

motion upon the highest portions of its surface far swifter than we have ever witnessed. The rail-cars under full way go by us at the rate, sometimes, of forty miles an hour; and how sublimely swift, then, is their course! How soon they are away in the far distance! In rare instances, their speed is increased to the rate of sixty miles an hour, a mile a minute. But this is a terrible speed, whether we are on board or witnessing it from outside. The pigeon's flight is not far from a hundred miles an hour, and that of a cannon-ball is probably five or six times greater, which, by the earth's daily revolving upon its axis, people on and near the line of the equator are, every hour, borne, by its stupendous rolling, a thousand and forty miles eastward, or $17\frac{2}{3}$ miles every minute, or a mile in less than four seconds. Proceeding north or south from the equator toward the poles, the circles or parallels become less, as you will see by looking upon an artificial globe; so that, in rolling over of the globe, the people living on these small circles traverse, in the twenty-four hours, a less distance than those residing on or near the equator. At 20° either way from the equator,

for example, the circle surrounding the earth corresponding to the 20th parallel of latitude, instead of being, as at the equator, 25,000 miles around, is about 23,400 miles. At 30° it is 21,600, at 40° it is 19,080 miles, and at 50° it is 15,840 miles. Consequently, in the daily revolution of the earth upon its axis, those living at or near 20° north and south latitude, are carried eastward, not at the rate of $17\frac{2}{3}$ miles a minute as at the equator, but $16\frac{1}{4}$ miles ; and those living at 30° go 15 miles a minute, or a mile in four seconds ; those at 40° go $13\frac{1}{4}$ miles a minute, while, up at the 50th parallel, the velocity per minute is just 11 miles. So the rate of speed goes on diminishing toward the poles ; while, if a man shall, sometime, stand upon the north pole—and there is a man or boy living who will stand there—and if he should stand perfectly still for twenty-four hours, and not turn to right or left, he will not be carried a mile nor an inch by the rolling over of the earth, but will simply be turned clear around, his face, as the globe goes round, turning successively in every direction toward the horizon.

If now you ask how it is that in going, as

we do in our latitude, at the amazing velocity of about 13 miles a minute, twenty-five or twenty-six times faster than the swiftest motion of the cars, how it is that we have no perception of such motion, two considerations may be a satisfactory explanation. First, we are borne along on an immense body and with a motion exactly uniform, and as perfectly quiet as is possible to be conceived. There is not a jar, not the least perceivable disturbance from year to year or from century to century. Then, secondly, the great atmosphere surrounding and enveloping the earth, being held to it by the force of attraction, revolves with the earth, so that the revolving of the latter occasions, in most circumstances, not the slightest friction between it and its atmosphere. Were this otherwise, and the revolving earth released from the overhanging atmosphere, and rushing through it and by it, and leaving it behind, the immediate result would be awful in the extreme. It would be the same as if an east wind were driving by us westward at the rate of a thousand miles an hour, or tenfold the force of the wildest and most awful hurricane; and in less than an hour's time every

tree would be uprooted and prostrate, every movable thing on the earth's surface would be flying in utter confusion through the air, and every human being and every animal would be swept away as with "the besom of destruction."

Here, too, then we should not forget to make a note of the great Hand that is ever near us, the hand of infinite power blended with infinite goodness and beneficence. He turns over this great world every day, carrying us and all things with it, while yet this amazing daily revolution goes on with perfect quiet, constancy, and safety. Could we witness the great and swift revolving without participating in it, it would probably be a sight too sublime and awful for endurance. Yet, could we bear it, doubtless the very first conscious reflection would be that the rush of this great world upon its axis must be a rush to utter and dire destruction. But, amid this enormous whirl and this apparent ruin, the infinite One is near, and he "upholdeth" and we are safe.

Earth's Motions Imperceptible.



IN the preceding sketch I presented reasons why the motion of the earth, so swift as it is, is not perceptible by us who are carried along with it by day and night. Some one may ask why, though the motion is perfectly without jar or disturbance, we do not perceive it to be rolling by objects that are distant and stationary, as, for example, the stars at night. Why do these stars, and the sun, and the moon, appear to be going by us if we are moving instead of them? The appearance to every one is that these are always drifting westward while we remain stationary. This is true, and is one of those optical illusions which all have experienced. If you can remember the first time you ever

rode in a carriage, you will recollect that the trees, though still as ever, seemed to be all in motion. Elderly people who had grown up before rail-cars began to fly over the country, can call up the curious sensation when they first intrusted themselves to those swift wheels. Looking out through the windows, it was as if the landscape were flying by us, instead of our flying through that ; and the hills and trees on land, and the ships away on the ocean, appeared combined in a prodigious race, and we seemed as if dropped down in the center of a vast whirl, and all nature was rushing, we knew not where. So often, even now, while sitting in the cars along-side of another train within the depot, and one or the other train begins to move slowly away, it is not so easy for me to tell which of the trains is moving, whether I am gliding one way or the neighboring train the opposite way. So I suppose it is apt to be of all unusual motions, in which we participate. Those who, especially at first, venture to ascend in balloons, realize this illusion to perfection. Ascending, it is not that they are rising from the earth, but the great earth is sinking down

from them ; and when far aloft, it is not that they are drifting eastward, but the earth, and cities, and rivers, are all gliding westward ; and being whirled around in their airy car, it is not they that are whirling, but the great underlying landscape is rushing round like some mighty wheel ; and essaying to descend, it is not that they are coming down to the earth, but the immense earth, with all that is upon its surface, is coming up to where they are. And happy for them if the enormous world does not come up too swiftly, and give them a blow too terrible and deadly ! Indeed, the balloon in the air is probably as exact and fine an illustration of our position in space as is possible. The balloon is moving, but appears to its passengers to be utterly still—it is running before the wind, but no breath is felt, for the great silken ball is moving precisely with the breeze. So seems this great solid globe as, upon its surface, we are borne ever onward. The seeming is that we are still, very still, and that it is the sun and stars that are on the wing.

I have fancied that a simple experiment may, by an effort, dispel for a little moment

this inevitable illusion, and show us a transient glimpse of this great earth's motion. You will recollect that this globe, by a motion exactly uniform, performs a perfect revolution of 360 degrees in twenty-four hours. Of course it revolves 15 degrees in one hour, a motion too slow to be perceptible. Hence, we do not perceive the motions of the stars westward, but only that they *have been* moving, and that their places are changed from hour to hour. Were they moving westward, instead of 15 degrees an hour, about double that number, their actual moving would be perceptible, and the whole vast starry concave would be seen rolling very slowly toward the west, as the earth, at this rate, would be actually rolling eastward upon its axis. And yet by the help of a bright and perspicuous mark the motion, as it is, may seem to be perceived. Assume, for instance, a favorable situation, perhaps an elevated window that looks off, without an obstruction, upon a smooth, eastern horizon. Take your position just before the full moon is about to rise. As it begins to make its appearance, then, by a determined mental effort, *make it stationary*, and *make the great earth move beneath it*; and,

if you succeed, you shall, for a moment or two, seem to conquer the illusion, and see the great and sublime reality—the motion of the earth. If any one is pleased to affirm that all this is but imaginary, I have only to reply that there are imaginings which are identical with realities.



Diurnal Revolution.



It was not until recent times that the revolution of the earth upon its axis was credited as a fact. All mere *appearances*, you know, are against such a theory. There seems to be nothing pertaining to the earth itself, or to the firmament above us, that would indicate such a curious arrangement. The earth—is it not steadfast, firmly established, and immovable? Is it not as plain as any thing we see that the sun literally rises in the eastern horizon, and goes down at evening in the west? The moon and the stars, also, do they not follow the same order? Thus thought all the world, through long ages. The great world where we live was the center of things, and the sun, and moon, and stars, like Jacob,

his wife, and sons to Joseph, came and bowed down to this central earth, and made obeisance to it. Or, more literally, they arose upon it, circled over it, and set behind it, and passed under it, and came again to the place of beginning. The firmament, as was the seeming, was a vast, solid, revolving canopy, bedecked with the greater and lesser lights, and passed over and around us forever. So it looked—so the Bible seemed to teach—so the learned and the wise believed. At length, not far from the middle of the sixteenth century, Copernicus, a German philosopher, having for some time doubted the Ptolemaic system of Astronomy, which had been in vogue for 2,000 years, and which placed the earth in the center of the universe, with the sun, moon, and stars revolving around it, came, by long and careful study, to the clear conviction that the sun, instead of the earth, was the true center, and that the earth was one of the planets, and, like the others, revolved around the great luminary; and that the cause of day and night was not that the sun really rose and set, but that the earth turned regularly upon its axis, thus meeting, as it turned, the sun at morning and

turning away from it at evening. Copernicus declined, for a long time, to publish his theory, and it was not till the last day of his life that his newly published work, in which it was set forth and illustrated, was presented to him. Shortly afterward, in 1564, Galileo, the Italian philosopher and mathematician, was born, who also arose to eminence, and became a confirmed convert to the Copernican theory, and alleged that the Scriptures, so far as they speak of the connection of the sun and the earth, were to be understood as speaking *popularly* rather than *scientifically*; and thus did not contravene the Copernican theory. A formal charge was presented against him before the Roman Inquisition, and he was compelled to recant his teaching of the Copernican theory. Accordingly he abjured the doctrine with solemn formality, and, clad in sackcloth, and kneeling upon his knees, he swore upon the Gospels never again to teach that the sun was stationary, and that the earth moved. He declared his detestation of the heretical opinions, and promised to perform the prescribed penance. Then, rising from his knees, he muttered in an undertone, "*It* [the earth] *does*

move, for all that !" So absurd is it to attempt by compulsion and persecution to change the well-settled convictions of the human mind !


As, then, the sun is the central and stationary body, and the earth one of the planets revolving around it, it must, in order to the beautiful alternation of day and night, such as we actually see, turn upon its axis each twenty-four hours. Otherwise the same side of the earth would be always turned toward the sun, and the opposite side be always away from it—an arrangement which would condemn our globe to utter loneliness and desolation, without an inhabitant or any green thing—one hemisphere a stark, blazing, frightful desert, and the other a vast and terrible wilderness, bound up in everlasting frosts, and bald, dark, and dreadful forever. To prevent so sad a result, the great Creator, who is blessed for evermore, has given our world its diurnal or daily revolution ; and it is remarkable that whatever other motions among the planetary bodies may be subject to slight perturbations or changes, the uniformity and exactness of the earth's daily rotation upon its axis is absolutely perfect. Place anywhere upon the globe

an index pointing exactly to a particular star away in the heavens, and if you note the interval elapsing between the pointing to-night and to-morrow night to that same star, you may also note that exactly the same interval will elapse between any two successive pointings, while a long century of years shall pass over you. This immense clock, suspended by the Almighty Father in the heavens, contrived, wound up, and regulated by his own hand, varies not a moment from age to age, but, by its own calm and stately revolution, measures off the years and centuries with absolute exactitude. What a demonstration is this of the existence and perfection of God! How otherwise could such an instance of perfection be accounted for? Here is an effect; and so grave, so astonishing, so beautiful and complete, beyond every finite operation. Was there not an operator? and was his power and skill less than infinite?



XI.

Night.

HUS we have day and night. And has any one ever, as yet, appreciated the excellence of this same arrangement? "The evening and the morning were the first day;" and so it has gone on, without a single interruption, through thousands of years. At evening, the part of the earth where we dwell rolls away from the sun and the latter is hidden from sight; that is, it sets. For a little time, however, it is but just below the western horizon, so that it still illuminates the atmosphere above, causing what we call the *twilight*. As the earth still rolls further away, and the sun, by consequence, is further beneath the horizon, the twilight grows less and less until it entirely ceases, and then we

call it *night*. The sun and his light are now entirely withdrawn, and by the withdrawal of this greater light, the stars appear; and if the sky is clear of clouds, the stars afford some light, so that it is not quite dark through all the night. But if the night is cloudy, and the clouds are heavy, and the moon is absent, the night is very dark, though rarely if ever perfectly so.

But whether clear or cloudy, how sublimely interesting is the night-time, and the deep, dense, immense shadow that overspreads all the world so far as we can discern! Darkness, of itself, is deeply and solemnly impressive; and as, at night, it enshrouds the great landscape in every direction, it is truly awful to contemplate. We fail to recognize this from its perfect familiarity or commonness. We never have known any other arrangement. In our earliest consciousness it was so. Our infant eyes opened and saw the light, and they saw it go away and come again from day to day and from night to night, and we grew up amid the constant and curious alternation, and grew familiar with it, and came to know and love it we know not when or how, and now even

the dark night is welcome to us, and in our long familiarity we have forgotten that it is otherwise than agreeable. Often, indeed, when children, out-of-doors alone in the night-time, its awfulness would impress us painfully, if not frightfully. Even now, as we sometimes, in our wakefulness, rise from our beds at "dead of night," peer out through the lattice and contemplate the "shadow of great darkness" that is upon the earth, a feeling of awe comes over us such as we are not generally conscious of. He that would appreciate what the night really is, should endeavor to imagine what would be his sensations if, after having lived always in daylight, he should, for the first time, behold a night, such as now comes on us daily, settling over the world! Then, indeed, would the change be to us such as would be *felt*. It would be a strange occurrence truly, and as great and marvelous as strange; and men would think, and talk, and discourse, and print about it long afterward. And tidings of the amazing shadow would be told to children and to children's children, and furnish an important page in history, and travel down through long generations.

NIGHT.



Some such an unusual night actually comes, at times, to one and another region of the earth. The sun, it is true, is aloft—it may, in fact, be high noon when this night comes on. It is brief, to be sure. The “hour of darkness” tarries only from one minute to about seven minutes at the longest. People call it solar eclipse, as we know; but it is a veritable night. It is dark, the sun has set and the stars are out, and the domestic fowls seek their roosting-places, and the birds of the air hush their notes and rest their wings, and the kine go lowing homeward to the steading, wondering that night has come untimely, and people, old and young, forsake their houses, and are all of them abroad in the streets and fields to look on this brief but extraordinary night, and see this huge yet transient shadow come and go. This is all well, and natural, and proper. At the same time, we may well ask, what is the setting of the sun behind the earth? this darkness of two or three minutes to the darkness of long hours? To us the shadow of the moon is strange and greatly noticeable; that of the earth, though vastly greater and larger, and of longer continuance,

is, however, a daily event, and therefore unappreciated.

But sometimes in the dark night we bethink ourselves of what would be if it should continue, and day should delay to return. In such an awful contingency night would begin to assume an aspect inconceivably awful and dreadful.

"I had a dream, which was not all a dream.
The bright sun was extinguished, and the stars
Did wander darkling in the eternal space,
Rayless, and pathless, and the icy earth
Swung blind and blackening in the moonless air;
Morn came and went—and came and brought no day.
And men forgot their passions in the dread
Of this their desolation; and all hearts
Were chilled into a selfish prayer for light."

But fear not. The earth that in the west rolled upward last evening, is still rolling calmly, and swiftly, and surely; and we who, a few hours ago, lost sight of the sun behind us, are hastening around to meet him again in front; and already arises another twilight in the eastern instead of the western sky, and it is growing brighter and brighter, and there appears the sun again, and the earth, as it rolls on, is already setting beneath the magnificent orb of day.

Setting

XII.

Day.



F the nights on this earth are so interesting and sublime, what shall be said of the day? It is early morn;

let us rise and dress and issue forth abroad and look and listen. Perhaps it is near the Summer solstice. If so, we were aroused from slumber by the "sweet notes of earliest birds," breathing their little artless songs from a thousand tree-tops, and making vocal the surrounding landscape. The air is balmy, and gentle zephyrs are breathing from the deep pure cisterns of the atmosphere. Meanwhile, the dawn is clear and full, and speeds itself along the eastern heavens, reaching almost from pole to pole. There now comes the sun, at first "a little line of insufferable brightness which,

spread

before I can write these few words, has increased to half an orb, and now a whole one," and the wide world is illuminated, and, under the genial radiance of the morning sunshine, lies enrobed with beauty. "The manifestations of the power of God," said Daniel Webster, "like his mercies, are 'new every morning,' and fresh every evening. We see as fine risings of the sun as ever Adam saw, and its risings are as much a miracle now as they were in his day, and, I think, a good deal more, because it is now a part of the miracle that for thousands and thousands of years he has come to his appointed time without the variation of a millionth part of a second. Adam could not tell how this might be. I know the morning, I am acquainted with it, and love it; I love it fresh and sweet as it is—a daily new creation breaking forth, and calling all that have life, and breath, and being to new adoration, new enjoyments, and new gratitude."

Onward and upward the great warm sun pursues his way, reaching, at length, his southern summit, and the day is perfected. How different these underlying lands, and streams, and forests from what they were only last

midnight! What a new, bright world has the day so suddenly brought forth! How strangely has that pall of darkness, so deep and immense, been lifted all away, and how blue and pure these skies, in whose vast concave those clouds are gently drifting as when sunlit sails are wafting afar over the Summer sea! On go the pleasant hours, and day is waning. The sun is now hanging in the western firmament, and hastens presently to his "golden rest." What magnificent hours have passed over the world as this mighty sun was circling through the heavens! It was the luminous, sprightly reign of Day; and along his brilliant realms Industry was plying her energies—great enterprises were planning, city streets were swarming with life, and gay with animation and beauty, and country landscapes were joyous with far-reaching meadows, golden harvests, waving forests, blushing flowers, silver streams, and all nature's splendid garniture.

Thus the night and thus the day, and while so extremely opposite and diverse, how pleasant as well as necessary their constant alternation! We hinted at how dreadful night would be if, in the midst of it, no morning

were forthcoming. And constituted as are ourselves and our dwelling-place, how wearisome and ruinous would be incessant day! That great sun always above us, and always beaming down upon us, instead of being a friend, would become a terrible enemy; and, as suggested in a former letter, would soon transform our earthly dwelling-place into a scene of desolation. All the beautiful influences of night upon the animal and vegetable world would be lacking, and its friendly shadow, so helpful to quiet stillness and peaceful and refreshing sleep, would never come to infold us in its soft arms and bless us. Incessant sunshine and intense heat would speedily generate mortal sickness, and we should look up in our desolate weariness, and long for night with its cool shadows and the music of its reviving breezes.



XIII.

The Seasons.



THE revolution of the earth upon its axis produces, as we have seen, the alternation of day and night, but does not explain the different *Seasons*, as Spring, Summer, Autumn, and Winter. A simple arrangement produces this result, while yet it is difficult of explanation without the aid of an orrery representing the sun and earth in their respective positions relative to each other.

Suffice it to say that the phenomenon of change of seasons proceeds from two astronomical facts combined ; namely, the revolution of the earth around the sun, which makes the year, joined with the fact that the earth, in performing this great round, has its North Pole always directed to the same point in the

heavens—this point being very near the North Star. The North Pole being always thus directed, the earth's axis, instead of being perpendicular to its path in space, or upright, leans away from such perpendicular about $23\frac{1}{2}$ degrees, so that, at a certain season of the year—the Summer season—the sun shines upon the North Pole and beyond it, while the South Pole is in darkness. In our Winter time, on the other hand, and when the earth is on the opposite side of the sun, the latter shines upon the South Pole, while the North Pole is in darkness. Meantime we dwellers in the temperate zone, occupying an intermediate position between the pole and the equator, experience a gradual transition from Summer to Winter which we call *Autumn*, and another from Winter to Summer which we call *Spring*, and thus we have four annual seasons distinctly marked.

And this variety of seasons is one of the deeply interesting phenomena belonging to our earth, and is doubtless designed by the Creator to constitute one of its capital attractions and delights. *Spring*, for example, has a charm which can be felt but never described; and

few memories of our hearts are so beautiful as those of the Spring-time of our early years. And even in later life, the giving way of stern Winter and the sweet breath of approaching Spring are more than welcome to us. It is not an unnatural suspicion that the present arrangement of the earth began with this lovely season, and it is quite likely that those first "evenings and mornings" were vernal ones, fragrant as they were with new-born flowers and young and gorgeous foliage, and the new up-springing of the tender grass over the graceful meadow lands, and amid the whispering groves of paradise.

This blooming season is the bright emblem of the glad months and years now passing over my youthful readers. You are amid life's happy Spring-time, and its freshness and blossoming are upon you; while, if good and true, these morning days of yours are the fair promises of still happier years.

Nor is it less interesting when the Spring season melts away into the glories of *Summer*. Those suns, how gorgeous are they; and goodly are the maturing foliage, the waving grain, the ripening harvests, the earth all

fruitful beneath, and the skies all blue and brilliant above! And then glance at that dark belt stretching far along the western horizon, and listen to the rumbling of the distant thunder, and note the firmament wild with clouds, and the trees all suddenly surging hither and thither by the rushing blast—fore-runner of the mighty shower now drenching the thirsty landscape. And then, anon, the retiring storm-cloud is seen lying off darkly upon the eastern sky, still fraught with lightnings and vocal with thunders, while upon it hangs the “glorious bow,” the magnificent pledge that storms are gone, and that genial sunshine is returning to gild and beautify the rejoicing world.

And whose heart is not glad at the coming on of the grand *Autumnal days*; when Summer heats have passed by, and cooler airs glide over the landscape, and bright September days are here, and blissful October with its ripening fruits and balmy atmosphere, and crimson and golden forests decorating the landscape, as if a vast and magnificent flower-garden were spreading itself far away toward the distant horizon!




WINTER.

Winter, it is true, has its snows, and clouds, and storms, and cold, and shortened days, and lengthened nights. Yet this somber season, too, has its comforts and even its charms, its sublime scenery, and its instructive lessons. Artificial heat creates a little Summer within our dwellings—schools open their doors for the young, while the Winter season and its associations are more favorable to study and intellectual progress than other months, and the long evenings invite to useful books, pleasant converse, and innocent recreations; and then refreshing and healthful sleep prepares us to welcome the late-coming sunrise. Even the whitened and ice-bound landscape, with its naked trees and drifting snows, and all its wild and desolate aspect, is irradiated with blissful hope and promise. For as from our comfortable dwellings we gaze abroad over this Wintery desert, delightful visions pass before us of all this desolation being lifted off and dissipated, and these same fields and pastures presently putting on their flowery and fragrant robes once more, while every chilling sight and scene shall pass away, and “all things become new.” *wind*

XIV.

Equinoxes.

(MARCH 20—SEPTEMBER 21.)

AVING written of the different seasons, let us glance at four important eras of the year which may, in fact, be said to *introduce* the seasons. These eras are the two *Equinoxes*, and the two *Solstices*. We will first notice the Equinoxes. The term *Equinox* comes from a combination of the two Latin words *equus*, equal, and *nox*, night ; and hence it means *equal night*, and is accompanied, of course, by equal day.

Astronomers imagine two great circles in the heavens, and surrounding the earth ; one directly over the earth's equator, which they denominate the *Celestial Equator*, and crossing this at two opposite points another great

circle termed the *Ecliptic*. This latter circle is the path which the sun appears to traverse, not in his daily circuit, but in his annual course. Now, these two circles cross each other at an angle of twenty-three and a half degrees; and the sun, in his yearly round, will reach, of course, one of these crossings or junctions; and six months, or half a year, afterward he will come to the other. Thus he crosses the equator twice a year at nearly equal intervals—the times of crossing being the 20th of March and about the 21st of September.

At these two periods, the sun, being directly over the earth's equator, shines over the entire globe from pole to pole, so that on the precise equinoctial day of twenty-four hours, every square mile of the earth, as it rolls over from west to east, is illuminated by the sun's rays. So, also, in this particular twenty-four hours, the day and night are equal over all that portion of the earth where the sun, on that day, rises and sets; that is, every-where except at and near the North and South Poles. At these two localities, on the equinoctial day, the sun neither rises nor sets, but would be seen

directly in the horizon, one-half of it visible above the line, while the other half would be below the line, and invisible. In this position, during the equinoctial twenty-four hours, it would be seen circling around the entire horizon, neither rising nor sinking. A few, say ten, degrees south from the North Pole, the equinoctial sun, to a man who might be standing on our meridian, would be seen rising at the moment of its rising with us; that is, at six o'clock, and precisely in the east. But, instead of mounting promptly up the sky, he would, through all the morning hours, still be creeping near the horizon southward, and ascending but slightly, like as the careful boy in his first attempts at swimming, hugs the shore, fearful to strike out with his more skilled and bold companions into the deep, broad stream. Thus, at high noon, and after six hours upon his course, he would be seen lying in the far south, still only ten degrees—within a hand's-breadth—above the horizon, whence, for the next succeeding six hours, he would go circling down the western horizon, still gradually sinking, till, coming to the exact west, he will disappear. But it will be but a

bare disappearance. All night long—a night of just twelve hours—he will be hugging the horizon, though beneath it, and the man up there at eighty degrees, if he please to watch, may track the sun throughout the night by the twilight halo which he will bear with him to and from the far north, as he goes circling the pole. Another man, standing, that morning, upon the equator, will also behold the sun come up in the precise east. But instead of coursing away toward the south, he will make a sheer ascent upward, at right angles with the horizon, and, at the hour of noon, will be exactly in the zenith, and his rays will shoot vertically down to the earth, and this equinoctial man, as he walks hither and thither, will bear with him no shadow, and on every spare foot of land or water around him Sol's burning rays will fall with their maximum of intensity and strength.



XV.

Summer Solstice.

(JUNE 22.)



THE word *Solstice* comes from two Latin words, *Sol*, sun, and *sto*, to stand; and means that the sun *stands*; that is, makes no further progress north or south. There are two of these points, one north, the utmost limit of the sun's course north; and the other south, the utmost limit of his course south. These two points are called *solstitial* points; and the sun reaches the northern one to-day, June 22d; and hence, this, theoretically, is the longest day of the year. "Theoretically," we say; because there is just now, as the almanacs show us, little or no difference of the day's length, for several successive days. If,

for example, the sun reaches the solstitial point this day, there will, however, be but the slightest difference between the length of to-day and that of yesterday, and also that of to-morrow. This may be illustrated to some bright boy by supposing his hoop, which sometimes bounces against us on the sidewalk, to be notched into 360 equal parts; and as the hoop should rest upon the ground, and its top be made to lean toward him, a fly should be seen passing, with a uniform motion, over the circumference. As the fly should come up to the top of the hoop, and pass over a few spaces nearest to the observing boy, he would discern no difference in the fly's horizontal progress from right to left. Such is the picture of these passing days. But, still watching our fly after he passes over thirty or forty spaces, and as he is now descending the hoop, although traveling just as fast as before, yet his horizontal progress is decidedly less as he advances from notch to notch. Thus he is picturing to us the philosophy of the shortened days, which shortening will be so perceptible a few weeks hence. The sun will then be no longer solstitial, or apparently stationary, but

will be seen to travel a less distance from rising to setting.

The solstitial, or longest day is, with us, not far from fifteen hours long; and the farther north we go toward the Arctic Circle, the longer the day. Up at Stockholm and St. Petersburg, eighteen or nineteen degrees farther north than Chicago and Boston, the sun, to-day, will be eighteen and a half hours above the horizon. Consequently, this night in those cities will be but five and a half hours in length—the sun setting there about a quarter past nine o'clock, and rising a quarter before three. Also, by reason of the great obliquity of the sun's path, he will dip, at setting, but slightly beneath the horizon. So that the twilight will be visible during most of the brief night.

setting
A few degrees north of Stockholm, near the head of the Gulf of Bothnia, is a hill from whose summit the sun, to-night, will not disappear at all, but will be seen setting gradually from the western skies apparently nearer and nearer the horizon as it approaches the due northern point, when it will seem just to touch the earth, and then, as it passes the rocky point,

northern

it will begin to ascend again eastward on its long circuit of twenty-four hours. To the spectator upon that hill, Phœbus will seem to take no rest to-night. And many a spectator will be there to witness that great sight ; for it is one that fails not to attract annual steam-boat excursions up the Bothnia from Stockholm and other places. By proceeding a few miles further north, the excursionists might view the same spectacle without ascending any hill ; while should they journey to Ekon-tikos, about 200 miles above the head of the Gulf, they might enjoy a sunshine of three entire weeks, uninterrupted of sunsets—the sun, each twenty-fours, careering all around them—always in sight, and always rejoicing like a strong man to run a race. They would see him passing eastward and upward from our midnight to morning, southward and still upward till noon, westward and downward in the afternoon hours, and northward and still downward to the “place of beginning,” a little distance above the northern horizon.

Meanwhile, far away southward, along Patagonian pampas and forests, there reigns, on this our solstitial day, stern and relentless

Winter. And peering out from their gloomy huts, the dwellers there behold, lying off in the northern skies, the Winter sun traversing speedily his low, brief race, then disappearing through the long and dreary night.

But let these be of good cheer! To-day the sun starts away on his southern tour; and, at next Christmas-time, the tables will be turned, and the long nights, and Winter winds, and clouds, and storms, will be ours while the sunny and late-lingering day, and joyous birds, and brilliant flowers, and ripening harvests, will come to cheer the denizens of the South.


“Great and marvelous are thy works!
In wisdom hast thou made them all.”



XVI.

Winter Solstice.

(DECEMBER 22.)

OU will perceive that I have again dated my sketch. In the preceding one, I noticed the situation of the earth and sun in relation to each other, as their situation was just six months ago. Let us see how matters are now. The earth has gone half around its great orbit, and we are on the side of the sun precisely opposite to that where we were one-half a year since, and 190,000,000 of miles distant. And as the North Pole was then turned toward the sun, and as its direction never changes except very slightly, so now the same North Pole is turned away from the sun and the South Pole is toward it.

Now notice the sunshine as it rests upon the

earth. First, it shines fully upon the South Pole, and beyond it, all the time, and the rolling of the earth upon its axis does not hide the sun from this part of the earth through all the twenty-four hours. The sun continues to shine there just the same as if the earth were held perfectly still in that same position in respect to the sun. On, and a little space around the South Pole, the sun has been shining now for three months, ever since the 21st of September; and he will continue to shine there for three months more, or until the 20th of March. To-day, and for several days about this time, the sun shines all the twenty-four hours as far as to a line $23\frac{1}{2}$ degrees from the South Pole. This line you will notice as a dotted line on the map of the world, and it is called the Antarctic Circle. Then passing your finger up the map toward the north, you will notice a similar dotted line $23\frac{1}{2}$ degrees from the North Pole.

Now for the appearance of things on the earth on this 22d day of December. Beginning at the South Pole it is, as we have said, all sunshine, and has been for three months, and will be three months more. To-day,


the sun at the South Pole is at its highest point—that is, it is $23\frac{1}{2}$ degrees above the horizon, and will for the next twenty-four hours continue there, neither rising nor perceptibly sinking. Instead of this apparent motion, it will seem to go entirely around the world parallel to the horizon, and if a man should stand still upon the South Pole for twenty-four hours, beginning this morning, he would observe the sun first directly before him, $23\frac{1}{2}$ degrees up; six hours afterward, over his right shoulder at the same height; at six hours more, at the same height directly behind him; at the end of the next six hours, it would be at the same height over his left shoulder, and at the end of the twenty-four hours, it would, without any apparent sinking or rising, have come round in front of him again. Thus, for the three coming months, from this 22d day of December till March 22d, the sun, at the South Pole, will appear to be passing round and round, very gradually nearing the earth, until, at about the ninetieth round, it will have dipped half beneath the horizon, and in that situation, though slowly sinking, it will encircle the whole earth. Then, after another circling or two of twenty-

four hours, it will entirely disappear, and will be seen no more from March till September 21st. Come now from the South Pole $23\frac{1}{2}$ degrees to the antarctic circle. How is the sunshine here on this 22d of December? At noon the sun is, of course, in the north, and 47 degrees above the horizon; at 6, P. M., it is in the west $23\frac{1}{2}$ degrees above the earth; at midnight, it lies exactly at the south and in the horizon, half of it being visible; at 6, A. M., it is in the east, nearly $23\frac{1}{2}$ degrees up, having ascended thither since midnight, and without setting; at noon it is in the north again, at the place of beginning.

If, now, we please to transport ourselves away to the arctic circle, the condition of things will be exactly reversed, that is, the sun at noon will be half of it visible in the southern horizon—visible a few moments, and all the rest of the twenty-four hours will be night. At the North Pole, the sun will have been three months out of sight, and all this day will be $23\frac{1}{2}$ degrees below the horizon; and though it will begin to ascend from to-day, yet it will not make its appearance until the 22d of next March.

XVII.

Zones.

E have thus attempted to picture the scenery within the polar circles north and south, as the earth pursues its annual circuit around the sun. These dismal portions of the globe are denominated the *Frigid Zones*, and they are rightly named. They are realms of eternal frosts and snows, while, at the two poles, and for a considerable space around them, they have only one day and night in the year, each being six months in duration.

Thus you have noticed the two polar circles called, upon the maps—the northern, the *Arctic*, and the southern, the *Antarctic* circles. Now, with your eye upon the arctic circle, move it down the map of the world to within

$23\frac{1}{2}$ degrees of the equator, and you will notice another dotted circle, and at the same distance below the equator another similar one. These two circles, as you know, are called *Tropics*; the northern one, the tropic of *Cancer*, and the southern, the tropic of *Capricorn*. Glancing at the space on the map between these two tropical circles, and you have what is called the *Torrid Zone*, also rightly named, as it is the warmest region of the globe. Then glancing at the two spaces, one between the tropic of Cancer and the north polar circle, and the space between the tropic of Capricorn and the south polar circle, you see the two *Temperate Zones*—the former called the north temperate, and the latter, the south temperate. These, likewise, are properly named, from the fact that their average temperature is a medium between the cold of the frigid zones and the heat of the torrid zone.

Thus the earth is divided into five belts, zones, or divisions; and these are natural divisions rather than artificial. The torrid belt or zone, for example, comprises all that portion of the earth's surface, over which the sun is perpendicular, or in the zenith, twice a year,

and outside of which, whether north or south, it is never in the zenith. The two temperate zones comprise all that portion of the earth's surface upon which, while the sun shines obliquely, yet has the alternation of day and night, both comprising twenty-four hours. The frigid zones are those regions where a day or a night may be each from twenty-four hours to six months in length.

These last, as we have seen, are cold and dismal regions of the earth, having few human inhabitants, and those ranking low in the scale of intellectual or moral worth. On the other hand, the torrid zone, lying almost directly beneath the sun, and every point of it being exactly beneath it every six months, is the warmest region of the earth. Here no Winter ever comes, while there is little that resembles Spring and Autumn; but an everlasting Summer lords it over these immense regions of the globe. Here, of course, vegetation attains the greatest growth and perfection, and here is the home of the largest and mightiest of wild beasts, birds, and reptiles. Man, too, is here; but the enervating influence of the hot climate, joined with the little necessity of labor for

** twice a year.*

subsistence, renders him indolent and comparatively weak, effeminate, and inefficient.

Glancing at the two temperate zones, the south temperate is at once seen to embrace but a very small portion of landed surface. The southern points of South America and Africa, and the southern half of Australia, together with a few smaller islands, are all. The north temperate zone, on the contrary, embraces nearly all of North America, Europe, and Asia, and Northern Africa. This zone, therefore, is the important and main portion of this world of ours. Were this, with its people, to be annihilated or overwhelmed with water, little would be left that would be worth an existence. Here are the genius, learning, enterprise, industry, talent, wealth, happiness, and hope of the world, and ever have been, and will be.

And here it is that a great and beneficent Providence has placed my young readers and me. It was utterly beyond our control that we were born and reared somewhere along the most favorable belt of the earth's surface. At the same time of our birth, thousands of other children entered on existence, some in the

depths of Africa and other torrid lands, and others in the far north among the wild Kam-schatdales and Esquimaux, and they grew up amid moral darkness—will live low, and useless, and hopeless lives, and die “without the sight” of Jesus and his cross. Is it better, infinitely better with us? Who, then, ordered our earthly habitation? Whose glorious hand was it that placed us in the midst of the best of all lands, as He said to us, “This is thy dwelling place—thine arena of large beneficence—thy stepping-stone to life eternal!”



XVIII.

Continents.



WE have thus far noticed the shape, superficies, weight, motions, and different seasons of the earth—let us now look at the great world in some of its more familiar aspects.

Its first obvious aspect is its division into land and water. We hinted, in a former letter, that, at the creation, as described by Moses, the whole globe seems to have been covered by water. He pictures to us the creative work of the third day as thus: “And God said, Let the waters under the heavens be gathered together into one place, and let the dry land appear, and it was so. And God called the dry land *Earth*, and the gathering together of the waters called he *Seas*.” And

these are the two great natural divisions of the globe.

Let us contemplate the land division. And here, one of the first things that attract our attention is the small proportion of land compared to the water. As, at the creation, the waters subsided and left the land exposed, their subsidence ceased when only about a fourth of earth's solid surface was uncovered. To a vision that was capable of contemplating the divine operations, on that third day of the creation, it must have been a sublime scene indeed. The retiring or settling of the waters was probably quiet and gradual. The mountain-tops became first visible, and as the waters settled toward their bases, they loomed up as islands huge and bald. Then the wide-spreading continents slowly came into view, and the numberless islands, great and small, until the vast waters stayed forever. Then the earth was land and water much as it is now, but the land was merely such. Throughout its whole great extent, it was an absolute desert. Not a tree or shrub, nor a blade of grass was there. No green thing as yet appeared, but it was one bare, bald,

desolate scene over continent and sea, and from pole to pole. The *canvas* was indeed stretched forth, but nothing more; it was placed in readiness and waiting for the picture, and then said the great Artist, "Let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself upon the earth, and it was so. And God saw that it was good."

We have noticed how the land was curiously proportioned to the water, and we may add that its distribution was equally curious. It would have seemed likely to us that the distribution of the land would be somewhat equal on the several sides of the immense ball. But this is far from being the fact. For if you should divide the globe into two equal parts by a line passing through the North and South Poles and crossing the island of Iceland near the southern coast of Greenland, you would have on one side of the line all Africa, Europe, and almost all Asia, and the whole great island of Australia, and the neighboring large islands, while on the other side of the line will be only the continent of North and South America, Greenland, and a little corner of Asia. Thus

the number of square miles of land in the American or Western hemisphere of the globe is only about 15,000,000, while the square miles in the opposite or Eastern hemisphere is not far from 50,000,000—more than three times the extent of the land of the Western hemisphere. Why this great disproportion between these two halves of the earth, is one of the questions which philosophy fails to answer.

There is something curious, also, in the general contour or shape of the several great land divisions of the globe. If you place before you a map of the world on Mercator's projection, you will observe that all these divisions are wide on the northern sides, and that they have a tapering tendency southward until the most of them terminate in the ocean. Thus Greenland and North and South America in the Western hemisphere, and Africa and the several countries of South Asia, as Arabia, Hindostan, and Siam. For the explanation of this peculiarity, so far as any has been proffered us, we must refer you to writers on the geological phenomena of the globe.


It will be observed, further, that the great

land divisions of the world are thickly and often deeply indented with water in the shape of seas, gulfs, bays, inlets, etc. This might have been so, to a greater or less extent, when, on the third day of the creation, the waters subsided from a portion of the solid parts of the globe, while it is an undoubted fact, however, that many of these indentations have been greatly extended by the constant action and force of the water operating through a long course of ages. Nor is it at all unlikely that by this same process of the ocean waters very decided changes have been wrought in the character of some or all of the great continents. Probably, for example, the narrow isthmus joining North and South America, now averaging only about forty miles of width, was once very much broader, so much so that the Gulf of Mexico and the Caribbean Sea had no existence, and Cuba and the other West India Islands, instead of being islands as now, were a part of the solid continent. So the Asiatic continent once very probably included Australia and the whole archipelago between it and the present southern coast of Asia. And Africa, it is likely, was once joined to

Europe, as it is now joined to Asia, while the present Strait of Gibraltar was an isthmus, and the Mediterranean, Adriatic, and Black seas were inland lakes.

And here, too, my young friends must not be unmindful of the excellent working of our Heavenly Father's hand. These numerous indentations, by the ocean, of the great continental coasts, furnish abundant harbors for shipping, and for the important operations of commerce; and these operations and facilities would be greatly curtailed but for the arrangement we are contemplating. Take a common map of the United States, for example, and compare the thickly indented coasts of Maine with the smooth, bald coasts of South Carolina and Florida, and consider how much nearer perfection for commercial purposes is the former coast than are the two latter. Compare, also, the entire line of coast, from New Brunswick to the Chesapeake, with the opposite Pacific coast in the same latitude.

Oceans.

FROM the general view of the land surface of the globe, let us turn to notice briefly the ocean of waters.

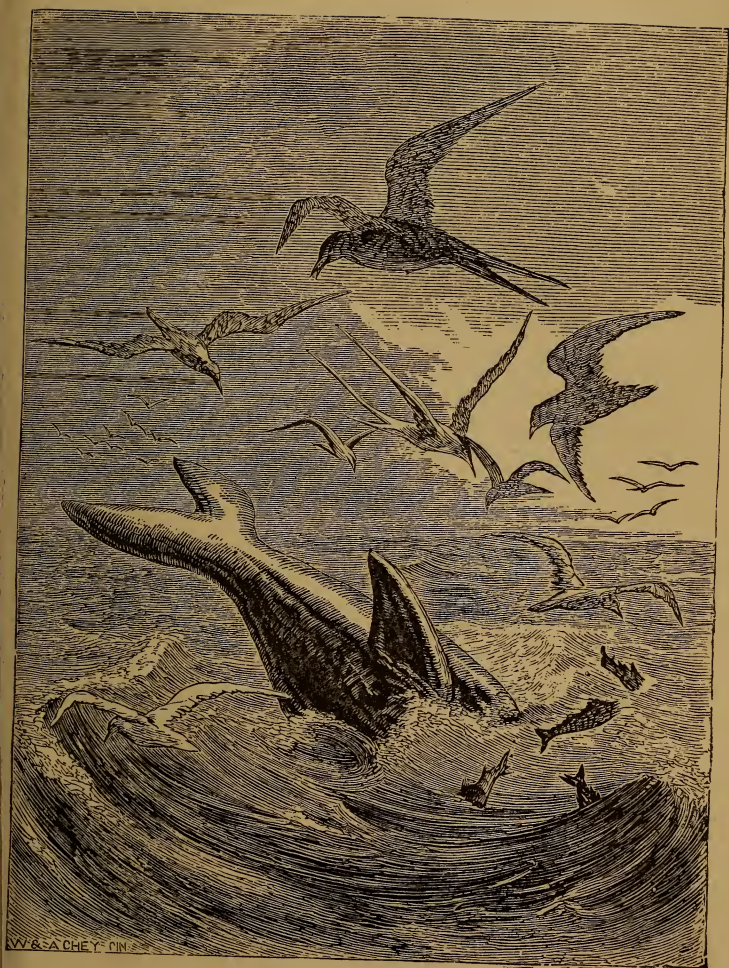
The ocean surface, as we have seen, monopolizes nearly three-fourths of the whole, and forms, in fact, but one body, being partially separated into different parts, to which, for convenience, we attach different names, as Pacific, Atlantic, Indian, Northern, and Southern oceans. This boundless expanse of water extends east and west entirely around the globe, and also from pole to pole; and the Eastern and Western continents are, both of them, huge islands reposing amid this vast waste of waters. Our globe, as to its surface, is a world of waters, while the landed surface

is quite a subordinate quantity. The waters are the globe, the land being spots scattered here and there upon the face of the interminable sea. There are positions away from the earth where an eye that could take in the whole hemisphere nearest to it would, out of twenty equal parts of the surface, see one part land and the other nineteen parts water. Afar off in the opposite direction, and where the other hemisphere would be wholly in view, the entire of the great continents would be seen except the southern parts of South America, while, except this portion and the southernmost points of Asia, the whole continental world would appear broadly surrounded by water including a great mediterranean ocean (the Atlantic) nearly as spacious as the whole continental surface.

Here, again, the *why* comes in, and again we are unable to answer. We know enough to be assured that the ocean is good and useful, but why it is best that it should be so extensive, so predominant, on this planet, I am not clear, nor, perhaps, is any one else; and in the presence of such an inquiry, as of a multitude of others, we can only take shelter under

the one and all-sufficient axiom that "He doeth all things well," and arranges nothing vainly, whether in the correct adjustment of land and water, or any other conceivable or inconceivable thing.

Some facts touching this great ocean world are interesting. In the first place, it is, and probably every-where, affected by currents, running in different directions. Sometimes a current upon the surface flows in one direction, while beneath this same current flows another in a direction precisely opposite. These currents exert an influence to preserve the quality of the sea water all uniform over the globe, and they serve, also, to modify the climates of different countries, rendering some of these warmer and others colder than they would otherwise be. In the second place, the ocean is *salt*. Whence this saltness is not clearly understood. It may be derived from geological formations with which the waters come in contact, or it may not. But whatever its source, there is reason for believing that the saltness of the ocean has a salutary influence upon the climates of the world, and this may be one of the reasons why this saline quality is made one of



THE OCEAN.

the characteristics of the ocean, as well as for the ocean's predominating extent upon the globe.

In the third place, the ocean is the sole fountain of all other water upon the earth, as rivers, lakes, springs, and reservoirs, and all the moisture of the earth, without which it would be utterly barren in respect to every green thing, and be spread forth an entire and uninhabitable waste. From the ocean's far-extended surface is drawn up by the daily sun abundant watery vapors, which are borne by the winds over the continents in the shape of clouds. From these come the frequent rains that water the earth, and a portion of which, sinking through the soil, becomes the supply of springs and fountains, while another portion of the fallen waters flows off over the surface, forming rills, and brooks, and rivulets, and rivers, that empty their waters again into the ocean, whence they originally came. Nor is it for us to say that the ocean, immense as it is, is any too capacious for the great purposes of evaporation and its salutary influences upon earth and atmosphere.

Then, fourthly, the ocean serves as the great

highway of nations, and is the grand medium of commerce between countries far separated from each other. Thus what might seem, and once did seem, an impassable barrier between these countries, becomes, in fact, a most facile pathway of communication and commerce, and far superior to such communication by roads upon solid land. A common steamship, for example, will carry from New York to Liverpool or Havre a thousand tons of merchandise in twelve days. The same amount transported the same distance by land, would require five hundred wagons, and so many men, and two thousand horses, while the time required for such a journey would be, at least, one hundred days.

The average depth of this great ocean of waters is judged to be not far from two miles. What is its greatest depth is not known, and probably never will be. Beyond a certain depth, it is exceedingly difficult, and perhaps impossible, to effect soundings. Various contrivances have been invented for making deep-sea soundings, and great depths have been reached and ascertained. A region of the Atlantic lying south-east of Newfoundland,

and extending from 41° to 33° of North Latitude, has been sounded to the awful depth of nearly eight miles, and no bottom reached. Still further south, bottom was found at the depth of eight and three-quarter miles. Two of the main difficulties in sounding these great sea depths are the under currents swaying the weight and line away from a perpendicular direction, and the great amount of friction upon a long line drawn through the water. This friction is greater at vast depth, than near the surface, as the water grows more dense downward, and the line in drawing up the weight is prone to break by reason of the great strain upon it. S

On the supposition that the average depth of the ocean is two miles, the whole mass of ocean water upon the globe is 240,000,000 of solid miles. A world of water indeed! yet were the globe hollow instead of being solid, it would be a vessel adequate to contain all this amount of water and about a thousand times as much more.

Mountain Systems.



ALTHOUGH, for the sake of distinction, we speak of several systems of mountains on the globe, there are, in reality, but two great systems, one upon the eastern, and the other upon the western continent; and to these two systems nearly all the minor systems properly belong. The grand system of the Old World extends easterly sheer across Europe and Asia, a distance of 9,000 miles. The great system of the New World runs from Cape Horn nearly parallel with the western coast, northerly through the two continents, 10,000 miles. The African and Australian mountains, however, may be said to be independent of these two great systems of the mountains of the world.

Of the European mountains, the Alps are the highest and most celebrated. They extend about 500 miles east and west, and occupy a breadth of from 80 to 200 miles; and it is a curious fact that their breadth is narrowest where the mountains are the highest. *Mont Blanc* is the loftiest summit, reaching a height slightly short of 16,000 feet, or a little more than three miles. *Mont Rosa* is nearly as high, 15,223 feet. Besides these, the Alps has, at least, one hundred peaks that are more than 10,000 feet in height, all of which are covered with everlasting snows. Most of these peaks are accessible, though the ascent of some of them is very difficult and dangerous. There are many passes over these immense mountains, the loftiest of which is the *Adler Pass*, whose height is 12,461 feet. The Pyrenees, between France and Spain, attain a height, in Mt. Maladetta, of over 11,000 feet for its highest peak, while the width of the chain is about the same as that of the Alps. The highest peak of the Carpathian Mountains is about 10,000 feet, and that of the Appenines, *Mt. Como*, nearly as high. The loftiest Scandinavian peak is about 8,000 feet, and the

highest summit in the British Isles is Ben Nevis, in Scotland, about 4,000 feet. Passing to the boundary between Europe and Asia, we meet the Caucasus Mountains, the loftiest of which reaches the great height of 17,800 feet, with many other peaks of over 10,000 feet.

Advancing eastward, we presently come to the tremendous Himalayan range, embracing elevations far exceeding any others on the globe. Here are multitude of summits much higher than Mont Blanc in Europe, while the loftiest elevation, Mt. Everest, attains the enormous height of 29,000 feet, about $5\frac{1}{2}$ miles, and is the highest mountain on earth, although several other peaks nearly equal this in height. Farther north is the Altai range of mountains, of which the highest summit is about 10,000 feet.

Of the African mountains, the Atlas range has, for its loftiest peak, a height of 11,400 feet. Several other ranges on the continent comprise mountains of much greater height, the loftiest not less than 20,000.

Returning to our own continent, the mountain systems are equally interesting with those of the Old World. In North America we have

the Alleghanies running parallel with the Atlantic coast, and extending, with some interruptions, from Alabama to Vermont. Their height is moderate, unless we include the White Mountains of New Hampshire, whose highest summit is one and a quarter miles. Far away westward, a thousand miles from the Alleghanies, arises the *Rocky Mountains*, stretching away 1,800 miles to the Arctic Ocean, with here and there a summit equaling the height of Mont Blanc. Proceeding 500 miles farther west and nearing the Pacific coast, we come to the great chain of the *Sierra Nevada*, taking, as they cross Oregon and Washington, the name of *Cascade Mountains*, and terminating with Mt. St. Elias in Alaska, a mountain about 18,000 feet high. In Central America are the Sierra Madre range, and many single peaks.

Then passing the Isthmus of Darien we encounter the prodigious chain of the Andes, extending along the whole western coast of South America, and, except the Himalayas, embracing the loftiest summits of the world. Here rise the sublime heights of St. Martha, Tolima, Antisane, Cayambe, and Cotopaxi,

each of them 19,000 feet in the air. Here, too, is Chimborazo, of nearly 22,000 feet, Aconcagua, 24,000 feet, while, among the Peruvian Andes, are elevations exceeding 25,000 feet above the neighboring Pacific.

It is proper to add that nearly all lofty mountains are embraced in some one of the great ranges. There are, however, a few such mountains that rise solitary and alone. Of these is Mt. Egmont of New Zealand, a grand example of the almost perfect cone, capped with everlasting snow, and visible far out at sea. Mt. Ararat, of Armenia, the summit on which rested Noah's ark, is a partial example, rising 17,210 feet above the level of the sea. The Peak of Teneriffe also stands alone in solitary grandeur, looking from above the clouds, down on the solitary ocean.



Dimensions of Mountains.



HAVING taken the preceding general view of the great mountain systems of the world, let us indulge a somewhat closer and familiar glance at these deeply interesting objects, the mountains ; for none of us should be satisfied with general and superficial notions of matters so magnificent and grand.

It is natural to look, first, at the immensity of these wonderful protuberances of the earth's surface. Nearly all the great mountains of the earth are connected with other mountains, so that it is more difficult to estimate properly their real dimensions. Also, it is generally difficult to estimate, by the eye, the height of lofty mountains. Standing near such mount-

ains, we fail to take in only a part of their altitude. The summit is invisible, being hidden from sight by the intervening convexities of the mountain surface. The Himalayas must be ascended several thousand feet before their tops can be descried, and he who would see those sublime peaks rising from the level surface five or six miles into the air, must need take a position scores of miles away from where the awful ascent commences, while the view from such a distance will necessarily diminish, to the eye, the actual elevation of the mountains. Yet, think of immense swells, or land billows, a hundred miles wide at their base and towering from one to five miles above the earth's ordinary level, and extending thousands of miles along the surface of the globe. And yet, what is the largest and loftiest of these huge mountains to that incredibly large globe on which they rest? It would take 666 mountains like the highest mountain in the world, piled one upon another, to reach from the center to the surface of this earth. And to the eye that could take in the whole lofty reach, what would be one other such mountain piled upon the 666th one? It would be seen,

indeed, but seen as a very diminutive affair with the 666 beneath it. It must be the head of a very small pin lying on the surface of a large artificial globe, that would faithfully show the proportion to the globe. Level down the great Pyrenees, says one, and spread them over France, and you will elevate the surface of that country but nine feet. Tear down the immense Alps, Mont Blanc and all, and spread them over Europe; and you have elevated that great continent only nineteen feet.

But why these mountains? what is their use? Much that we see, and probably much that we do not discern. Piercing far aloft into the humid atmosphere, they thence attract to themselves watery treasures, some of which flowing down their sides, and others collecting within their spacious mountain caverns, become sources of innumerable rivers flowing out to fertilize the surrounding country. Also, within the bowels of the mountains are gathered immense treasures of the mineral world; as coal, iron, copper, silver, gold, and other precious things, so necessary to multitudinous useful and ornamental purposes. And

further, it hath pleased our Heavenly Father to enstamp upon this dwelling-place of ours various striking and ornamental features, whereof the mountains are a conspicuous instance. How graceful the green hills! Also, how beautiful as well as grand the landscape ascending far upward, displaying, at first, its verdant openings; then, farther aloft, dense with far-reaching forests; then showing, at still loftier heights, a wilderness of gorges, rocks, and precipices, far above which commences the realm of eternal snows, culminating in that glistening peak piercing into the skies! And how rich, how gorgeous, the spectacle of the mellow clouds rolling up that mountain-side "before the rising glories of a Summer's morning!" How grand the mountain when the same cloud envelops it with those golden folds! And how eagerly we gaze as they lift off, anon, and leave the great mountain naked and alone in his glory!

Mountain Passes.



F course, these lofty mountain ranges of the earth are impassable, except in a few localities. These are called *Passes*; of which there are several, more or less celebrated, leading across the Alps, the Himalayas, the Rocky Mountains, the Sierra Nevadas, and other ranges. These passes rarely cross over the mountain summits, but more commonly follow up the ravines through which the waters flow down the mountains, and descend by a similiar path down the other side.

There are sixteen passes over the Alps, all of which, except two, can be used with carriages. The pass which is most noted and extensively traveled is that of Mont Cenis. Here

an admirable road was built by Napoleon in 1805. This pass is thirty miles across, eighteen feet wide, and 6,773 feet above the sea. The pass of the great St. Bernard is higher, being nearly 8,000 feet. This is famous for its "Hospice," or hospital, kept up by several monks, and where many unfortunate travelers, overtaken by snow-storms in crossing the mountains, have been rescued by the monks with the assistance of their dogs, and kindly cared for. The loftiest pass over the Alps is that of St. Cervin, which is more than 11,000 feet above the sea level. The passes of the Simplon and St. Gothard are also celebrated.

The passes over the Himalaya Mountains are, as you might suppose, very much loftier and more difficult than those of the Alps. The lowest of these passes has a height scarcely less than Mont Blanc, while several of them are considerably higher. One is between 18,000 and 19,000 feet, and another, the highest, is 20,000 feet, nearly three times the height of Mt. Washington. All these passes are, of course, terrific to travel over, while the rarity of the atmosphere, at such great heights, renders breathing very difficult, and the fatigue

dreadful to endure. "Animals are as much distressed as human beings, and many die. Thousands of birds perish from the violence of the wind, the drifting snow is often fatal to travelers, and violent thunder-storms add to the horror of the journey." One traveler, describing his journey over one of these tremendous passes, relates that he, with his guide, had not only to walk barefooted, from the risk of slipping, but they were obliged to creep along the most frightful chasms, holding by twigs and tufts of grass, and sometimes they crossed deep and awful crevices on a branch of a tree, or on loose stones thrown across. The scenery in traveling these awful passes of the Himalaya Mountains is said to be awfully grand and magnificent. "During the day," writes Mrs. Somerville, "the stupendous size of the mountains, their interminable extent, the variety and sharpness of their forms, and, above all, the tender clearness of their distant outline melting into the pale-blue sky, contrasted with the deep azure above, is described as a scene of wild and wonderful beauty. At midnight, when myriads of stars sparkle in the black sky, and the pure blue of the mountains looks deeper

Terrible

still below the pale white gleam of the earth and snow-light, the effect is of unparalleled solemnity, and no language can describe the splendor of the sunbeams at day-break streaming between the high peaks, and throwing their gigantic shadows on the mountains below. There, far above the habitation of man, no living thing exists, no sound is heard; the very echo of the traveler's footsteps startles him in the awful solitude and silence that reigns in these august dwellings of everlasting snow."



Mountain Ascents.



ANY travelers, especially of late years, are not content in their mountain excursions to confine themselves to the passes leading across them, but not a few scale them to their summits, and feast themselves to the full with the sublimity of the scenery presented to their view. These ascents of lofty mountains, however, are no mere holiday affair, but they are performed with much labor and fatigue, and are often attended with danger to life and limb; and lives have frequently been lost in attempts to perform these perilous ascents, while many others have barely escaped the same frightful destiny. No one should attempt the ascent of lofty mountains but such as can uniformly exercise entire self-

control—who can look down huge precipices without agitation, who can, at will, command their eyes away from what is fearful, and fix them coolly and exclusively upon the perilous steps they must take. The greatest dangers of climbing Alpine steeps are said to be these: The first is in crossing the snow bridges which become formed over deep chasms that yawn amid the glaciers of the mountains. These bridges are apt to yield when stepped upon, and not a few adventurers have thus fallen into unknown depths, and were never seen afterward. A second danger is in slipping upon steep slopes of hard ice. When the feet thus give way, the traveler runs the utmost hazard of sliding over some one of the awful precipices that abound upon the mountain-sides. A third peril is that of being overwhelmed and buried under frightful avalanches of snow and ice that frequently come rushing down from the upper heights.

To escape the peril from snow bridges and from slipping upon icy slopes, travelers are accustomed to tie themselves together by a strong rope around the waist, so that if one should slump or slip, he will be held by the


others, and thus escape the destruction which he would, otherwise, almost certainly meet. And even this precaution does not always avail. A most melancholy disaster occurred in the Summer of 1865 upon the "Matterhorn" Alp. This is perhaps the most remarkable peak of the Alps, if not of the world. From a glacier summit of 11,000 feet ascends a tremendous peak sheer up 4,000 feet more, and nearly as steep as a thimble placed upon its open end upon a table. Four men, one of whom was a British nobleman, and another a minister of the Gospel, scaled, by some means, this awful obelisk. They were connected to each other by a rope, and soon after commencing their descent, one of the men slipped, which produced so great a strain upon the rope that it parted between the two uppermost men, when all the three that were below the fracture of the rope went immediately over the huge precipice, and fell through the whole 4,000 feet. The nobleman and the minister were of the three that thus miserably perished.

There are places on this earth that were not designed for men, and where man should never venture; and he who does thus venture,

travels away from the arms of a protecting Providence. We think these adventurers must have no sooner commenced the attempt to accomplish that most perilous descent before realizing that, in all probability, they were lost men. It was a poor ambition that doubtless urged them up thither, and who can avoid the conclusion that they "died as the fool dieth?"



Mountain Experiences.



DOUBTLESS some of my young readers, will travel in foreign countries, and will see for themselves, and ascend some of the lofty summits of the Alps or the Andes. If so, your first approach to these sublime eminences will be deeply interesting to you. Previously, it may be, you shall have looked only upon hills which, though seeming lofty, were yet smooth and green to their very tops. But the spectacle will be very different as you will approach some one of the great mountain ranges. At first, and when seventy-five or a hundred miles away, they will wear a dim appearance, like clouds lying far off in the horizon; and their tops will put on the aspect of wavy ridges, not

unlike the ocean billows, as when, off at sea, they are rolling by us, and in the dim distance there will be little or no variety of hue. Approaching nearer, you will begin to observe a striking difference. The summits that, when far off, appeared so rounded and comparatively regular, have now grown jagged and pointed, and the great range has loomed up into an immense wall, and the whole reach of the horizon in that direction is hidden. For a space, perhaps, the protuberances may be nearly equal in height, and then, at right and left of these, tower up far above them mightier eminences surmounted by several peaks or needles piercing the overhanging sky, or sometimes some crowning summit, as Mont Blanc, seen from the Brévent, will sit above them all, his top showing a graceful pyramid upon which you might seem to ascend and repose almost without an effort. Or contrasted with this, if you shall be approaching Zermatt, then the tremendous Matterhorn will be in full view, springing directly from its mountain base of 11,000 feet, and shooting almost perpendicularly another 4,000 feet into the upper air. Meanwhile the mountain-sides are no longer

dim and of uniform hue. Huge dark precipices lift themselves far aloft, sometimes as they descend, hiding themselves behind intervening and lower eminences, or cut off at right, or left, or both, by grim dark gorges or ravines through which ragged glaciers are slowly making their way down from the upper regions; while all aloft, eternal snows, intermingled with the bold, bare rocks and precipices, hold their solitary and desolate reign. Meanwhile, the nearer view shows you that it is not a mere mountain ridge or chain that you are approaching, but, rather, an immense congeries or cluster of mountains—some nearer and lower, and others farther and loftier; or, when nearer ones appear the loftiest, between the nearer summits other huge peaks are seen lifting themselves in the rear, and appearing embosomed in a mighty embrace of neighboring mountains.


At length, when all is in readiness, you will commence the ascent of some one of the great summits. Reaching the top of one elevation, another at once presents itself, which, in its turn, is also scaled; while, after several such ascents, the great summit seems as far aloft,

and as far off, as before you started. Then there comes on a change beneath your feet. You left, at starting upward, green fields, and pasture lands, and fragrant flowers. You are now treading upon moss instead of grass, and the verdant landscape is changed to a russet hue, and the weather has grown cooler, and trees, if any are left, are stunted and unsightly. Presently, still ascending, vegetation mainly ceases, and bald rocks and ledges succeed, the latter sloping off over precipices thousands of feet downward. It now becomes severely cold, and you have reached the realms of snow and ice, and everlasting frosts, and you must not wonder if, aloft upon these dismal heights, you shall encounter storms and whirlwinds more violent and wild than you ever before conceived. Passing yet farther upward, you may possibly emerge into a calmer region, where the storms and tempests will be seen raging far beneath you, and you will see lightnings and listen to thunderings in a direction in which you never noticed them before, that is, far below instead of above. Amid these awful heights where you are now groping your way still upward, you will need to be greatly

circumspect and careful. Sometimes you will be creeping along the edge of a precipice almost frightful even to think of, and where a single false step might plunge you into ruin. Here, again, the ascent is so steep and slippery that every step must be first cut into the solid ice with a hatchet. Beware as you attempt crossing that deep crevasse sinking hundreds of feet down amid the ice depths. But you persevere, and the great Hand has upheld you on your path of peril, and you have reached the summit. But, alas, you must go down again! You will need the same Hand along the more perilous descent.



Sacred Mountains.

OUNTAINS are always sublime ; and it is not so strange that they should be objects of notice in the Holy Scriptures, and more or less associated with the Divine communications to our earth. Some of these Scripture mountains should attract the notice of young readers, for the very reason that they are named and noticed in the sacred oracles.

Of these *Mt. Ararat*, in Armenia, is first noticed in the Bible. Its great height has already been named, and, also, that it is one of the few lofty mountains of the world that stands partially solitary and alone. It has, however, a double summit though one base, the lower summit being 3,000 or 4,000 feet be-

low the higher one, and the two summits are nearly seven miles apart. Many attempts have been made to reach the top of this mountain, all of which were unsuccessful until a German, Dr. Parrot, in 1829, after two vain attempts, succeeded in a third effort and gained the awful apex. The summit was slightly convex, almost a perfect circle, about 200 feet in diameter, and composed of smooth, eternal ice, unbroken by a rock or stone. By reason of the immense distances of objects, nothing could be seen distinctly. The permanent snow capping the mountain extends from the top three miles down the sides.

This mountain is famous as being the eminence where the ark rested when the great flood was subsiding, and whence Noah and his family descended after the drying off of the waters, and where the human race and the various tribes of lower animals commenced, a second time, to spread themselves over the earth.

Mt. Moriah is early named in the Scriptures, it being the eminence where Abraham was directed to offer up his son Isaac. From its altitude it hardly merits the appellation of

mountain, being one of the hills which make the foundation of the city of Jerusalem. It is the eastern summit, overlooking the vale of Cedron, and was the site of the famous temple of Solomon, and the second temple, and is now the site of a Mohammedan temple, the Mosque of Omar.

Sinai is noticed in the Bible in connection with Moses and the giving of the law to the Israelites after crossing the Red Sea. Sinai is the name assigned not to one particular eminence but to a group of mountains in Arabia Petrea. There are numerous peaks ranging from 1,000 to over 9,000 feet above the sea; on which of these summits the great Moses ascended to meet God and speak with Him "face to face" travelers and writers are not agreed. Dr. Robinson, whose authority is perhaps equal to any other, assigns the honor to the mountain named *Ras Sassafeh*, a summit between 7,000 and 8,000 feet high, before which open out two wide valleys capable of containing the great host of the Israelites.

Mt. Hor is also a mountain of Arabia Petrea, on the confines of Idumea, and is only mentioned in the Scriptures in connection with

Aaron. It was to the summit of this mountain that he was led up to die in the presence of Moses his brother, and his son Eleazar, as described in the 20th of Numbers. The ascent is extremely steep and toilsome, the mountain is craggy and wild, and to one upon the summit, the crags are represented as standing upon every side in the most ragged and fantastic forms, sometimes strangely piled one upon another, and sometimes as strangely yawning in clefts of a frightful depth.

As Mt. Hor was famous by reason of the death of Aaron upon its summit, *Mt. Pisgah* is more famous for the death of the great Moses. It is a mountain of Moab commanding a view of the desert eastward and westward, a view of the Jordan and the promised land beyond. It seems to have been nearly identical with *Nebo*, which was probably one of the peaks of the Pisgah range.

Here was represented to the eye of Moses a panoramic view or vision of Canaan in its length and breadth, and then he died; died alone, and only God was present and officiated at his funeral.

Mt. Horeb seems identified with Sinai much

as Pisgah is with Nebo, and is illustrious from two or three notable facts of the Bible history. It was upon or near this mountain that Moses was tending the sheep of his father-in-law, when there came to him this solemn call from God to conduct Israel from Egypt to the promised land. Also somewhere here it was that he smote the rock for water, and where, in connection with this transaction, he most unfortunately spoke unadvisedly with his lips, and by reason thereof was forbidden to enter the land of promise.

Mt. Carmel is a ridge in Palestine, branching off from the mountains of Samaria, and extending, by a north-west course, sixteen miles to the Mediterranean. Its highest point is 1,750 feet above the neighboring sea. While the entire ridge of Carmel is represented as wild, and rendered hideous by the presence of wild beasts, many of its slopes are described as very beautiful, being sprinkled with oaks and green with rich pasture-lands, where myriads of wild flowers of every brilliant hue are scattered in abundance over the splendid landscape.

Repeated and interesting mention is made

in the Scriptures of Mt. Carmel, and with its beautiful name are associated some of the fairest of sacred imagery, as well as some of the marvelous transactions of the olden time. The great and solemn Elijah often lingered amid its fragrant groves, and somewhere here he, with his altar, confronted Baal's prophets with their falsehoods, and, invoked the divine fire, and slew them before God, and ascending the summit, offered the "fervent and effectual prayer" for rain until appeared the little cloud like a man's hand. Here, too, at times, sojourned his associate and successor, the mighty Elisha; who, somewhere in sight of the mountain, recalled to life the Shunamite's little beautiful boy. Also not far off was the scene of David's eventful interview with the graceful and judicious Abigail, whereof the sequel was nothing less than a royal wedding after not many days.

Lebanon is a celebrated mountain range of Syria, extending from the northern limit of Palestine, north-easterly over a hundred miles, and whose loftiest summit is 10,000 feet above the sea. The mountains of Lebanon are famous both Scripturally and classically, and the view of them from the Mediterranean is said to

be exceedingly grand. They appear to rise from the bosom of the deep like a vast wall, their loftiest summit always covered with snow. To these mountains the allusions in the Scriptures are too numerous for specification, and the magnificent cedars clothing their lofty sides were favorite emblems of beauty, grandeur, and prosperity.

Mt. Olivet, standing out immediately before the east front of Jerusalem, and separated from it by the brook Cedron, is prominent among the sacred mountains. At its base is Gethsemane. Bethany lay just over its principal summit, whither the Savior of men often resorted to repose, for an hour or a night, amid the pleasant hospitalities of Martha and Mary, whom, with their brother Lazarus, he specially loved, and whence he called the latter back, for a time, from paradise, and where was the sacred dust, the last that was touched by the beautiful feet of the Master as he went away to his Father.

Mt. Zion, too, the southern summit of Jerusalem, is wreathed all over with affecting and sunny associations. "Beautiful for situation" was it in the olden time, and royalty dwelt

there, and heavenly song ascended thence, and there was heard the golden harp whose blissful notes were listened to and loved in heaven, and that was the sacred summit honored as the bright emblem of the celestial fold, and the name whereof is assigned to the great spiritual kingdom, whether on earth or in heaven, of God's Messiah.

"For ye are not come to the mount that might be touched, and that burned with fire ; but ye are come to Mt. Zion, the city of the living God, the heavenly Jerusalem, and to an innumerable company of angels, to the general assembly and Church of the First-born which are written in heaven, and to God the judge of all, and to the spirits of just men made perfect, and to Jesus."

Finally, westward of the city, and "without the gate," was *Mt. Calvary*, named and known only, and forever to be named and known only, as the theater of the *great crucifixion*. The Cross, the Victim, the Blood, the Death, the Life, the Eternal Salvation, these are its whisperings. Traveler! tread softly there and listen: "Christ hath redeemed us from the curse of the law, being made a curse for us."

Plains.



F the mountains of the earth are sublime objects, the great *Plains* of the several continents are scarcely less so. These plains comprise vast areas mostly level, and comparatively at but a small elevation above the level of the ocean. Through them the rivers mostly flow, and they are, for the most part, the inhabited and cultivated regions of the earth, and are often exceedingly fertile.

Beginning with our own continent, a comparatively narrow plain lies between the Atlantic Ocean and the Alleghany Mountains. Crossing the Alleghanies, between these and the base of the Rocky Mountains west, and between Hudson's Bay and the Arctic Ocean

north, and Mexico with the Mexican Gulf south, is a vast plain cut by the Mississippi and its numerous tributaries, and nearly all of which, except the far north, is a land of great fertility and capable of the largest production. East and North, and all along many of the river courses, it comprises extensive forest lands, while immense tracts are destitute of trees and have received the name of *prairie*. The most of this immense plain belongs to our country, and comprises nineteen entire States and Territories, besides parts of several others.

South America is as famous for its prodigious plains as for its lofty and magnificent mountains. The great basins of the Orinoco, Amazon, and La Plata Rivers, comprising the greatest portion of that land, may be said to constitute one far-reaching plain, stretching through the entire length of the continent. Much of the portion covered by the inundations of the Amazon is a great forest land, dense with trees, and, by the decay of the forests for ages, it is a land of excessive fertility. But much of it is impracticable by reason of the luxuriousness of the vegetation,

and for this and other reasons is unfavorable for human occupation. As Mrs. Somerville writes :

“The heat of these extensive regions is suffocating in the deep and dark recesses of these primeval woods, where not a breath of air penetrates, and where, after being drenched by the periodical rains, the damp is so excessive, that a blue mist rises in the early morning among the huge stems of the trees, and envelops the entangled creepers stretching from bough to bough. A death-like stillness prevails from sunrise to sunset ; then the thousands of animals that inhabit these forests join in one loud, discordant roar, not continuous, but in bursts. The beasts seem to be periodically and unanimously roused by some unknown impulse, till the forest rings in universal uproar. Profound silence prevails at midnight, which is broken at the dawn of morning by another general roar of wild chorus. Nightingales, too, have their fits of silence and of song ; after a pause they

‘All burst forth in choral minstrelsy,
As if some sudden gale had swept at once
A hundred airy harps.’

“The whole forest often resounds where the animals, startled from their sleep, scream in terror at the noise made by bands of its inhabitants flying from some night-prowling foe.”



Plateaux.



TABLE-LANDS, or *Plateaux*, are also a prominent feature of the land surface of our earth. These are also plains; and they differ from those described in the preceding sketch by having a greater elevation above the ocean level. They are a sort of medium between common plains and the lofty mountains of the globe; and are, in many instances, inhabited by man, and even comprise extensive and populous cities.

The highest table-land on earth is Thibet of Asia, lying north of the great Himalaya Mountains, a cold, inhospitable region, where human habitations are found at a height above the ocean about equal to that of Mont Blanc, in Europe. Besides this prodigious plateau,

Asia contains other immense reaches of table-land. The countries of Mongolia, Persia, Armenia, Asia Minor, and Arabia, partake largely of this character.

Plateaux abound, also, in Europe, although of less elevation than most of the Asiatic table-lands. Much of Spain is an elevated plain, and the city of Madrid stands between 2,000 and 3,000 feet above the ocean level; and the plateau of Bavaria, of Central Europe, has about the same elevation. The southern part of Norway and Sweden is higher still, being about 4,000 feet above the surrounding waters.

In Africa, Abyssinia is a cluster of plateaux, separated from each other by mountain chains. One of these plains is 9,000 feet aloft. The great Sahara desert is somewhat elevated, and, from five or six degrees south latitude to the Cape of Good Hope, the African continent is supposed to be a vast table-land.

Passing to our own continent, table-lands are also frequent and extensive. From the Missouri River to the base of the Rocky Mountains is a great plateau gradually ascending for 500 miles. So also between the Rocky Mountains and Sierra Nevada is


mainly a table-land, being 4,000 or 5,000 feet higher than the ocean. Turning toward the south we have the great table-lands of Mexico, the most extensive in North America. On the highest of these plateaux stands the City of Mexico itself, 9,000 feet above the neighboring Atlantic and Pacific seas, while to the south-east stretch away the lofty plains of Guatemala and Honduras, having an elevation of more than 6,000 feet, and Chihuahua is similarly lofty.

Passing the Isthmus, South America has some of the most elevated and remarkable table-lands in the world. That of upper Peru is, next to the plains of Thibet, the loftiest on earth, being nearly 13,000 feet above the sea, and is surrounded by the loftiest summits of the Andes. Quito is 9,000 feet upward, while the streets of Potosi are 12,822 feet above the Pacific, and Lake Titicaca, a little distance north, is nearly as high.



XXVIII.

Depressions.

HILE contemplating the regions of the globe thus elevated from 2,000 to 16,000 feet above the sea level, it is curious to note certain regions which, though of comparatively limited extent, are below, instead of above, this great level. The aspect of these localities is as if they had, by some stupendous pressure, been sunk down below the average surface of surrounding lands. The Dead Sea of Palestine, together with the Sea of Galilee, sixty miles north of it, and the River Jordan and its valley lying between the two seas, comprise a region of this character. The Sea of Galilee is about 500 feet lower than the Mediterranean Sea, while the Dead Sea is nearly 1,000 feet lower still. This is the

deepest depression below the great sea level that exists on earth. On the east side it has rugged mountains between 2,000 and 3,000 feet in height, while on the opposite or west side the hills have a height of about 1,500 feet, their tops being just about on a level with the Mediterranean Sea lying 100 miles west of them. The whole scenery is one of utter gloom and desolation.


Another, but a very different depression below the great sea level, is a part of the country of Holland. Thousands of acres of this curious country lie below the ocean, and are shut in from it by immense dikes or dams, erected and sustained at great public expense. Of course there is no natural drainage for such a country, and hence, in order to rid the land of superfluous water coming in by the rain or otherwise, multitudes of windmills are in constant operation, pumping the water over the dikes into the sea. These dikes have been, many times, broken through by the ocean, causing terrible floods over the country, and great losses of life and property. Nearly two hundred of these great inundations have occurred in Holland since the beginning of the

Christian Era, and there have been instances in which more than 100,000 persons have been engulfed. The latest, and one of the most terrible, transpired so late as 1825. And yet it is a country of marvelous fertility, picturesque scenery, and boundless wealth. The vast number of marshes, dikes, and canals, covered with ships which seem to move in the midst of windmills and avenues of trees of the richest verdure, impart to the greater portion of Holland an aspect of an extremely unique and original character, heightened by the presence of numerous charming country residences, towns and villages, of painted houses, washed externally from top to bottom every week, and of unparalleled neatness.

There are several other depressions, both of land and water, in different regions of the globe. The surface of the Caspian Sea, for example, and a great extent of country around it, is lower than the level of the ocean. Also Lake Assal, in the north-east of Africa, is 600 feet below the sea level.

XXIX.

Valleys.

E have written, in the preceding sketch, of certain remarkable depressions of the earth's surface, where large spaces of both land and water are sunk below the level of the ocean, and, in some instances, hundreds of feet below. Between these and the plains of the earth are extensive intermediate regions, lower than the plains yet lying above the sea surface. These are called *Valleys*; and they form another very interesting feature of the globe. They are of all dimensions, from the little verdant reaches, lying inclosed amid lofty mountains, to extensive territories covering thousands of square miles. These latter are more generally traversed by the rivers with which the earth

abounds, the streams meandering through them, sometimes midway, then wandering away far toward one or the other side of the valleys in which they are embosomed. Thus, in England, we have the valleys of the Thames and the Severn; and on the continent is the famous valley of the Rhine, sometimes open and expanded, again shut in within narrow limits by mountains approaching the river. Another, of more imposing dimensions, is the valley of the Danube, spreading itself far away and forming the plains of Wallachia. Famous, also, is the great valley of the Ganges in Asia, and of the Amazon in South America, and the Mississippi Valley of our own country. Yet where, as in some of these instances, they extend hundreds of miles on either side of the river, they seem to partake more of the character of *plains* than valleys. A valley, to display its true character and beauty as such, needs to be so limited as that its boundaries, either in whole or in part, may be distinctly visible. In such a case, it often presents to the eye some of the most beautiful landscapes of the earth. Take, for instance, some elevated and favorable position

overlooking the valley of the Hudson or the Connecticut, the Thames, the Rhine, or hundreds of other rivers, and you will witness what will very nearly fill your idea of a terrestrial paradise.

One of the most famous of the valleys of the earth is the vale of Cashmere, in the extreme north of the great country of Hindostan. It is of an irregular oval form, surrounded by lofty mountains, whose summits are crowned with eternal snows. Its level bottom is about seventy miles long and forty wide, although the entire valley extending to the very base of the mountains comprises about double this space. Thus wherever, along this vale, one might be living or traveling, the entire great mountain wall inclosing it would be conspicuous. A river—one of the tributaries of the Indus—traverses, with an unruffled current, the midst of the valley, receiving, in its passage, a multitude of tributary streams, while, here and there, beautiful lakes and numerous natural fountains, sending their sparkling waters into the air, give variety and picturesqueness to the resplendent landscape. All European fruits and fruit-trees flourish here in

perfection: as the apple, the pear, the peach, the plum, the apricot, the various nuts, and grapes in untold abundance, and in every conceivable variety. Also, the air is fragrant with flowers of every hue, and of gorgeous beauty growing wild amid those genial and fairy lands. The country is dotted with villages, each one embowered amid groves of chunars and poplars of enormous growth, and planted centuries ago by order of the Mogul Emperor. At the same time, the climate is mild, salubrious, and healthy, and the Cashmerians are pre-eminent for their physical perfection—the men being tall, robust, and well formed, while the women are famous for their beauty and the brilliancy of their complexion.

Such is one of the most famous valleys of the world. Yet we are obliged to be reminded that even Cashmere is not heaven. Amid all its magnificence of landscape, and its surrounding grandeur, they tell us that frequent earthquakes are there, and, what seems stranger than this, famine and pestilence sometimes make their baleful path into this paradise and slay their thousands in a few days of time. Moreover, though inhabited by comely men

and beautiful women, they are represented as very much "lower than the angels," being given to gayety and pleasure, and being "peerless in cunning and avarice, and notoriously addicted to lying."

Thus, I am suspicious, we shall ever find matters amid this fallen world of ours. There is no perfection under the sun. The serpent gained access to the first Paradise, and he is wherever, on this earth, some lovely Eden spreads itself abroad before the delighted vision. Let us up and away, for this is not our rest. Over all this world "God has set one thing over against another, to the end that man shall find nothing after him." But

"There is a world we have not seen,
Which time can never dare destroy ;
Where mortal footstep hath not been,
Nor ear hath caught its sounds of joy.

It is all holy and serene—
The land of glory and repose ;
And there, to dim the radiant scene,
The tear of sorrow never flows."

One word more, however, touching the valleys of the world. While, in many instances, they form the most beautiful dwelling-places for man, they are in general largely character-

ized by fertility as well as beauty. The valleys of the Nile, the Ganges, the Amazon, the Mississippi, and a thousand others are illustrations.

And yet one word more. Valleys may be said to be the great natural highways of the world. Often they are traversed by navigable rivers ; and these of themselves furnish a path for travel and commerce to an almost unlimited extent. The Mississippi River, with its system of navigable tributaries, opens up a length of steam pathway of 15,674 miles, and then thousands of miles more beyond the head of navigable waters these river valleys furnish practicable courses for the railroads, and other roads, of countries, where, with the fewest obstructions and impediments, they may establish their firm foundations. So true it is that immense utility, as well as varied and widespread beauty, characterizes the great valley system of the world.



xxx.

Deserts.



DESERTS are those regions of the earth which, by reason of their barrenness, are unfitted for the abode of civilized man.

There are districts of country where rain seldom or never falls, and where, as a matter of course, vegetation is either very scanty or wholly wanting, and nakedness and stark desolation lord it over the gloomy scene. Here and there, indeed, at distant intervals, and where, by some means, a certain degree of moisture, greater than elsewhere in the desert, prevails, some scanty grass and stunted trees hold a sickly and feeble life. These spots are called *Oases*, are generally of but limited extent, and are scattered over the vast desert as isles amid the ocean.

Deserts occur in various regions of the world; but as the term *Desert* always seems, in our minds, synonymous with *Sahara*, and as this is considered a grand type of all desert-lands, I shall confine my remarks to a slight survey of this one huge and awful realm.

The *Great Sahara Desert* monopolizes all of Northern Africa, except a comparatively narrow region along the Mediterranean, and also the valley of the Nile. Its dimensions comprehend fifteen degrees of latitude, and thirty degrees of longitude. In other words, it is nearly 3,000 miles in length, with an average breadth of 1,000 miles. Commencing at the Atlantic Ocean, it spreads sheer across the African Continent to Egypt, overstepping which, the desert is repeated along the western shores of the Red Sea. Crossing this, it monopolizes much of Arabia, and extends away toward the north-east, throwing its blight upon considerable portions of Persia, Thibet, and Tartary.

The great African Sahara is, in the main, an immense barren and desolate region. The surface is extensively of sand, though not universally so. Nor is it a dead level; but the

sand is often, by the violent winds, piled up into hills or enormous drifts, thus enhancing the hideousness of the general aspect of the landscape, and increasing the difficulty of traversing it. When these great sand-storms occur, the whole air is dense and darkened with the driving dust, and the unfortunate traveler is in imminent danger of suffocation, while the whitened bones scattered over the desert, tell something of the numbers that have thus miserably perished. At times, instead of loose sand, you encounter a hard, flinty surface of the desert, with dark ranges of rock towering up before you, and adding to the wildness of the scene.


Along extended portions of this dreary waste, it never rains, and water is nowhere to be found. Here and there, at intervals of several days' journey apart, and where, by digging, it is possible to find water, wells are sunk for the purpose of supplying travelers and caravans urging their long and weary journey over the desert. As these wells are often far apart, it becomes necessary, in passing from one to another, to carry forward upon the camels a sufficiency of water to preserve life till the

next well is reached, and then if this be dried up, as not unfrequently happens, death is almost certain to the hapless voyager.

At the same time the heat of the desert is excessive, rising at noon in Summer-time to 107, 120, and even to 140 degrees. Added to these horrors, wild beasts infest these desolate regions. Worse than all, the wild and wandering Arab prowls over the desert—the genuine Ishmaelite—his hand against every man, and every man's hand against him. As he wanders hither and thither over this “waste, howling wilderness,” his genius is that of a robber and murderer, and woe to the poor stranger that falls into his hands.

Such is one of the dark and strange features belonging to our earth. Here stretches afar a prodigious area, equal to that of the whole United States and Territories, all unfit for the residence of civilized man. Why thus, I can not inform you. I may say, however, that civilization proceeds well without the aid of this great desert realm, and there is yet very “much land to be possessed” before human population, enterprise, and welfare will require the occupation of Sahara.

Earthquakes.

ARTHQUAKES are among the most interesting and awful phenomena belonging to the history of our globe. An earthquake is an actual agitation and skaking of the earth, more or less violent in its movement, and more or less extensive in its reach. This phenomenon is probably owing to the energy of elastic vapors confined far down beneath the surface of the earth, struggling for vent, and acting with force inconceivably great and terrible. Some countries are much more subject to earthquakes than others; and it is noticed that they have the greatest frequency in countries subject to volcanoes, while it is altogether probable that the two disturbances have a similar origin. In

our own and many other countries, they seldom occur, and when they do their action is comparatively slight, as well as of limited extent.

On the other hand, some countries are greatly subject to them, and it is not unlikely that no day passes without the recurrence of an earthquake in some region of the earth. They transpire with the greatest frequency in such countries as some of those bordering on the Mediterranean, also Central America, and especially Chili and Peru of South America. In these two latter countries they are painfully common and destructive; and with a view to guard against them, the inhabitants are accustomed to build their houses low, and with thick and strong walls so as to insure, if possible, their stability against the earthquake shocks.

The coming of these awful visitations is described as not always after the same manner. Sometimes their first approach is with comparative gentleness. There is a rumbling sound like distant thunder, and its approach is distinctly marked by the increasing loudness of the noise until the shock reaches the spot where you are. At other times, the shock is

sudden and instantaneous, performs its work in a few seconds, and is gone. Often the shocks are repeated with short intervals, or the intervals may be longer. Then, again, the character of the motion may be different. Sometimes it seems to be a vertical motion, the ground under the feet rising and sinking in rapid succession. At other times, it seems a sort of undulating motion analogous to waves on the surface of water. At times, these motions are of great violence, so that the surface of the ground is broken, and yawning chasms are formed; and these are sometimes so wide and deep that buildings and people are suddenly engulfed in them, and the chasm suddenly closes up again, burying alive the unfortunate victims. Large trees and whole cities have thus, in some instances, been swallowed up. Sometimes torrents of water are ejected from the newly made chasms, and smoke and flames have been known to issue from them. Most of these more violent and terrible earthquakes occur in the neighborhood of the sea, and this seems to be as strangely affected as the land. At first, the water retires unusually, leaving the shores or harbors dry—a sad pre-

sage ! For, suddenly, the water returns in the shape of an enormous wave surging up over the city, and over a wide extent of country, hurling vessels far inland, whence they can not again be launched upon their native element. By this one operation thousands of lives have been destroyed within a few seconds.


How calamitous and awful have been the devastations of earthquakes ; I subjoin a few specific facts for illustration. In 1692 the island of Jamaica was visited by an earthquake, when the capital city of the island sunk directly down with the great part of the buildings. More than a thousand acres thus sunk in a moment of time, and the sea rolled over the entire area. A still more dreadful catastrophe befell the island of Java in 1772 ; a neighboring volcanic mountain fifteen miles long and six broad, with forty villages and their inhabitants, suddenly sunk beneath the waters.

Of the great earthquake at Lisbon, Portugal, in 1755, you have doubtless read. In that terrible earthquake, within six minutes of time, most of that beautiful city was shaken to pieces, and 60,000 people perished. As the buildings were falling thousands of persons sought safety

upon a new and extensive marble quay, when it suddenly sunk like a ship foundering at sea, and not one of the thousands of bodies ever reappeared; and the water where was the quay stood six hundred feet deep. The extent of this earthquake was computed to be greater than four times that of Europe. It was felt in the Alps, in Germany, Sweden, Great Britain, Northern Africa, West Indies, and extensively in this country.



Earthquakes of 1868.

UT the year 1868 must be set down as emphatically the great *Earthquake Year*, when a series of earthquakes occurred in this Western hemisphere to which history furnishes no parallel.

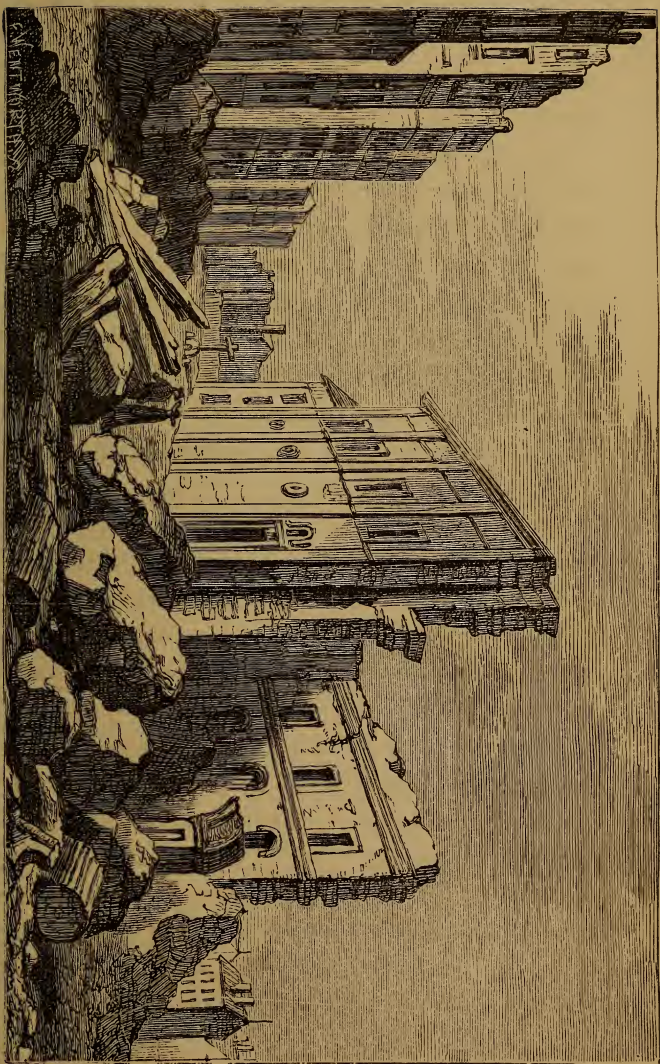
This great exhibition opened at the Sandwich Islands in connection with an extraordinary eruption of the volcano *Mauna Loa*. Simultaneously with this volcanic eruption the earthquake commenced, and it was estimated that, in the course of twelve days, there were 2,000 shocks, followed, at intervals, by fearful waves flowing in from the ocean, and destroying villages and their inhabitants. The severest shock was on the 2d of April, causing much destruction of property and life. About eighty

persons perished, and a multitude of domestic animals.

But the Sandwich Island earthquake seems to have been a trifle compared to what happened, a few months afterward, in South America. Here the first shock was felt at Arica, Peru. This town was utterly destroyed, and a multitude of people were killed. Several ships in the harbor were wrecked by the tremendous wave which, at a great height, surged in and overwhelmed the city, and bearing with it vessels, and lodging them miles inland. At Arequipa nearly every house was leveled, and five hundred people were drowned. Numerous cities along the Peruvian coast were partially or wholly destroyed. From Calao to Iquique, the entire coast of Peru was left in a complete state of desolation and ruin.

Three days after this terrible earthquake, another, more terrible still, occurred in Ecuador. The report of this earthquake, communicated to Secretary Seward, by our Minister to Peru, Mr. Hovey, will give us some idea of the terrible scene. These are a few of the items:

Eight towns with the adjoining populations and haciendas are said to have been destroyed,



THE EARTHQUAKE.

numbering from 40,000 to 50,000 inhabitants. The cities of Otavato and Cotachi, consisting of 20,000 inhabitants, were swallowed up with their entire population. Ibarra was destroyed with 10,000 people. Atunlaque was leveled with the earth, burying all its inhabitants. The destruction was not confined to the cities, but numerous and rich farm establishments, producing large numbers of cattle and sheep were all destroyed. To add to the other horrors, terrific thunder-storms literally deluged the whole country.

"These shocks," writes Mr. Hovey, "have almost ruined the Republic of Ecuador."

At various other points in South America these terrible earthquakes were felt, and the entire loss of life there is estimated at 30,000 persons, and the loss of property at \$300,000,000,

About two months following the South American earthquakes, California was also visited, and at San Francisco several lives and much property were lost, while other places in California were affected. After another two months, Mexico also was severely shaken.

Thus from Chili, far up toward Oregon, an

extent of thousands of miles, the Western coast of North and South America and the neighboring islands, were most seriously affected by earthquakes, and all within the compass of a few brief months. Whether these are to become frequent, it is presumed that no one can predict. But it certainly belongs to us to exercise great and special gratitude to the Father of mercies, that our own country seems to be, in great part, exempt from these terrible visitations.



XXXIII.

Volcanoes.



IN a preceding sketch I observed that the cause of earthquakes and volcanoes is probably much the same.

Elastic forces of tremendous energy are operating in the bowels of the earth, sometimes producing earthquakes, and sometimes forcing an opening through the crust of the earth from which are belched forth heated gases, sometimes in flames, "volumes of steam, eruptions of ashes mixed with scorix, and large stones which are often red-hot, and currents of melted rock, called lava."

Such is a *volcano*, named thus from the Latin *Vulcanus*, the god of fire. The matter issuing, as above, through the earth's crust forms a hill or mountain around the opening or crater,

and this mountain, by the accumulation of matter forced up from the earth's depths, increases to a height of hundreds, and, in many instances, thousands of feet. Thus we call a volcano a burning mountain; that is, a mountain from whose top or sides issues fire, or smoke, or both; and, in times of eruption, accompanied with lava, ashes, cinders, stones, etc.

Of these volcanic mountains, Humboldt counts 407, although there are probably very many more than this number. Only a little more than half of the number are active volcanoes, that is, continue to show signs of any thing issuing from their craters.

There are, indeed, three classes of volcanoes: first, those which were once active, but have been a long time still; secondly, those which are intermittent, that is, sometimes active and at other times quiet; and, thirdly, those which are always active. Of this last class, there are several that are celebrated, but their number is comparatively small. Of these and such of the intermittent volcanoes as have been in action within the last hundred years, there are reckoned 225.

Of the more celebrated volcanoes of the

globe we have *Vesuvius*, *Ætna*, *Hecla*, *Stromboli*, *Saugay*, *Cotopaxi*, *Mauna Loa*, and others. *Vesuvius*, down to the present time, has had sixty great eruptions, some of which were grand in the extreme. Its first known eruption was in A. D. 79, when it issued such an amount of cinders and ashes that two cities in the neighborhood were buried from seventy to a hundred and twelve feet deep, with most of their inhabitants. In its great eruption of 1632 the immense currents of lava overflowed most of the villages at its base. In 1779 the prodigious volumes of white smoke ascended in piles four times the height of the mountain, and stones and cinders were projected 2,000 feet above the top of the mountain. Columns of fire also shot upward more than 10,000 feet. In the eruption of 1794 a stream of lava issued from the mountain containing more than 46,000,000 of cubic feet. The eruption of 1822 broke up the whole mountain-top, producing a chasm three miles around it, and 2,000 feet deep. Recently great eruptions have occurred for several successive years.

The great volcano, *Mt. Ætna*, is on the eastern side of the island of Sicily. It consists

of a mountain between 9,000 and 10,000 feet high, from which springs the great cone of the volcano, rising 1,100 or 1,200 feet higher still. A delightful country surrounds the mountain at its base. Above this, and belting the mountain, is a magnificent forest, five or six miles in width, at the upper side of which begins the region of barrenness and desolation.

Eruptions of Mt. *Ætna* were known to the ancients as far back as 1,000 years before Christ. About sixty, in all, have been recorded, and, in recent times, those of 1669, 1755, 1787, 1792, and 1852, were the most important. That of 1669, in connection with the earthquake accompanying it, destroyed sixteen villages, and several vast fissures were opened in the sides of the mountain, emitting smoke, fire, and tremendous bellowings.

Cotopaxi is remarkable for being the loftiest volcano in the world. It is a mountain of Ecuador, South America, and its summit is near 19,000 feet above the ocean. Its figure is symmetrical, the crater nearly a mile in diameter, surrounded by a wall of rock below which, for nearly 5,000 feet, the mountain is inwrapped with permanent snow, so that its irregularities

of surface are mostly concealed. The eruptions are rare. In 1743 and 1744 were remarkable displays, when rocks of the size of small buildings were hurled from the crater to a distance of ten miles. The eruption of 1768 belched forth such an amount of ashes and cinders as turned day into night for miles round about, and at places twenty-five miles from the mountain the people were compelled to carry lanterns for the most of the day. In the eruption of 1803 its ashes were carried a hundred and thirty miles, and the explosions of the volcano were like heavy discharges of artillery. It then remained quiet for half a century, when in 1853, 1855, and 1856 it again became active.

But probably the most remarkable volcano in the world is that of Kilauea, on Hawaii, of the Sandwich Islands. The mountain itself is called Mauna Loa, and is 16,000 feet in height. It has two craters, one upon the summit of the mountain, and the other, Kilauea, much lower down its sides. The two craters are about sixteen miles apart, and by frequent eruptions, of late years, have poured out immense amounts of lava, sending prodigious jets to a

great distance into the air, and with explosions heard forty miles away. In 1865 a huge lava jet rushed at white heat into the air, sometimes a thousand feet, and continued thus for twenty days and nights without cessation, while the glare from the glowing lava, as it streamed aloft, was discernible by night at a distance of two hundred miles. The last great eruption, March, 1868, was alluded to in the preceding sketch.

But we must close these notices, though the theme is so deeply interesting. You that would gain a clearer idea of earthquakes and volcanoes, and of the terribly destructive effects of their action at different periods of time, should not fail to peruse Ponton's "Earthquakes and Volcanoes," a recently published volume, full of interest and instruction.


It will be very useful to my young friends to study well this great subject—one of the most wonderful of all the features of this wonderful globe which we, for a little space, are privileged to inhabit, and where, if we will open our eyes, unnumbered sublimities are constantly presented to our observation.

CRATER OF KILAUEA.



XXXIV.

Caverns.

LTHOUGH the earth is probably solid in the main, yet the subject of earthquakes and volcanoes, of which I have briefly treated, may remind us that it is not entirely so ; and while there are deep recesses where probably may be found the seats of those awful disturbances alluded to in my last three sketches, there are curious openings or caverns nearer the earth's surface, which may be said to constitute another interesting feature of the globe.

The great Humboldt divided the earth's caverns into three classes : of these the first are fissures in the earth, having only one opening ; the second having openings at both ends ; the third and most numerous and interesting

class comprises those which have a succession of apartments opening into one another.

This class of caverns has been found to exist in various countries of the earth, and some of them of very considerable extent and of exceeding interest. They frequently present a magnificent appearance, and are often ornamented with vast numbers of pillars sometimes variegated in color, and in other instances, of transparent whiteness with glittering stalactites in countless numbers hanging like huge icicles from the roof. They are, in fact, formed in the same manner with icicles, and of the same substance, water; the difference being that while the icicle is water frozen, the stalactite is water petrified, or turned partly into stone; the water trickling through the cavern roof being strongly impregnated with limestone. As only a part of the water is thus changed in passing down over the stalactite, the remainder dropping from its point forms another icicle, called a stalagmite, beneath it upon the floor. This is inverted, the points of the one from the roof and that from the floor being toward each other. These two points, in process of time, meet each other and

become one, thus forming those solid columns or pillars just alluded to, reaching from floor to ceiling of the subterranean apartment. The stalactites, however, do not always hang down in the form of an icicle, but, at times, take the shape of a great white sheet suspended from the top of the cavern. Sometimes this sheet is curved over a precipice, and thus has the aspect of a fall or cascade, as if, in the very act of falling over the precipice, it was suddenly congealed before reaching the depths below. Then, again, to the columnar form just noticed and sometimes superadded branches extending out in different directions, giving the appearance of glistening and magnificent groves of trees looming up amid the Plutonic landscape.

In some instances, these caverns seem to be partially inhabited. Certain reptiles, apparently of the serpent kind, have sometimes been seen in them, and Humboldt found a cave of Venezuela to be a habitation of prodigious numbers of birds of a "nocturnal species," and their clamor within the cavern was so tremendous as to render frightful its gloomy recesses, and was so appalling to the Indian guides that they refused to proceed ; and the


traveler was obliged to retrace his steps. Also, many European caverns present the phenomenon of bones belonging to extinct species of animals, and some of them well preserved. Human bones have been found in some caverns, but this is easily accounted for by the fact that caverns have, in various ages of the world, been used as cemeteries. Abraham, Isaac, and Jacob, with their wives, were thus buried.

Several remarkable caverns exist in our own country; as the celebrated Mammoth Cave in Kentucky, *Weir's* Cave in Virginia, Salt Peter Cave in Missouri, and one or two others. The last named has been recently discovered, and is reported as promising to rival all the others in extent and beauty. The Mammoth Cave has been extensively explored, and travelers have journeyed through its various passages, windings, and apartments, to the distance of ten miles from the entrance, have boated on its dark river, feasted upon its eyeless fish, and witnessed many of its gloomy wonders.



CAVERNS

Rocks.

GEOLOGISTS apply the term *Rock* to all varieties of substances composing the earth's crust, whether they be hard or soft. In popular language, however, we use the term to express only those portions which have become indurated or hardened; and thus we, in common style, distinguish between *rocks* which are hard, and *soils* which are soft.

Geologists divide rocks into four great classes in reference to their origin; namely, the *Aqueous*, *Volcanic*, *Plutonic*, and *Metamorphic*.

The aqueous rocks are such as are produced by the action of water. Here belong the limestone and sandstone rocks, also many of the slates, and gypsum. Of course, this class of

rocks is of prodigious extent upon the globe, and of great use to mankind.

The *volcanic* rocks are such as were produced by the action of fire, or subterranean heat. This is a far less extensive class of rocks than the aqueous. It comprises, of course, the lavas, and also the porphyries, greenstone, and the basalts, as well as numerous crystalline and columnal rocks.

The *plutonic* rocks comprise the famous granites, which are called plutonic from the great depth in the earth at which they are reputed to have been formed. The granites are also called *primitive* rocks, as having their geological place the lowest of all the rock, and, in fact, at depths too immense to be ascertained. Wherever we might please to penetrate down through all other strata of rocks, we should come, at last, to granite, as the foundation of them all; while still descending, we should encounter nothing but the same rock modified only by the influence of heat.

Granite is a composite rock, being made up of several minerals, and has various hues, as red, white, black, or gray, according as one or another of these minerals predominate in the

formation of the rock. For the same reason have been assigned to it several names or epithets, designating different qualities.

The granite rock is extensively used as a building material in the construction of bridges and various engineering works, also public buildings and dwellings, while for such purposes its excellence is unrivaled.

And as its use is thus extensive, so its abundance upon the globe is inexhaustible. Large extents of the earth's surface are covered with it. Countless and vast quarries are under our feet, and many a mountain is mainly composed of it, while it doubtless forms the axis or "backbone" of far-reaching mountain ranges.

And who is He that has ordained the most useful rock to be, at the same time, the most abundant? and from what principle did He so order?

The *metamorphic* rocks are a class comprising rocks of a highly crystalline texture. Marble, quartz, serpentine, gneiss, certain slates, and other rocks belong here.

Rocks, as we see them on the surface of the ground, in pastures and fields and of every

shape and size, some fast and some loose, limestone, sandstone, granite, conglomerate, etc., what are all these? They are fragments of rock—debris separated from large masses of rock; and by means of water, ice, and, perhaps, other agencies, were, in some age long past, swept over different regions and countries. Upon some localities—as, for instance, much of New England, New York, Pennsylvania, and Virginia—these fragments were drifted in large quantities, while farther west, and along the great Mississippi Valley, comparatively few were left as the great flood swept over it.

All this occurred not in our day, nor since the present arrangement of terrestrial affairs was instituted; and the aspiring youth, who would look up the “times and seasons,” must pass far beyond what is termed the historic period, and peer amid the mysterious geological ages.





THE ROCK AND THE LIGHT-HOUSE.

Minerals—Iron.



MINERAL is a name which is applied to any inorganic substance having a chemical composition. But for the various classes and orders into which mineralogists have arranged the mineral world, I must refer you to their several scientific treatises. It belongs to my province and purpose in these familiar sketches to glance at merely a few of the more prominent specimens.

Included among minerals are gases and salts of chemistry. Here belong, also, water, carbon, and sulphur. Here, too, are the metallic ores, as those of iron, zinc, arsenic, mercury, lead, tin, copper, and others. So, likewise, the metals themselves are reckoned as minerals, as well as those just named, as, also, the noble

minerals—gold, silver, and platinum. The mineral world comprises, further, all the precious gems, so much prized by both the civilized and uncivilized world. These are diamonds, rubies, emeralds, pearls, turquoises, opals, also the topaz, garnet, amethyst, onyx, and others.

Rich, then, is the earth in its mineral treasures, both such as are useful and such as are ornamental—while here is presented another capital feature, strongly illustrative of the munificent goodness of the great Architect. Let us note an example or two drawn from this untold abundance and variety of mineral wealth.

As one of these, we, of course, select *Iron*, at the same time the most useful and the most abundant of the minerals.

The application and uses of iron are innumerable, and range from works of the finest and most delicate character, to such as are the most ponderous and massive. Its capacity extends from a thread like to the finest gossamer to the huge anchor, fitted to hold to its moorings a ship of 10,000 tons. Hence, its adaptations are almost endless. “The most massive

metallic works," says one, "are made of it, and, also, the most delicate instruments, as the hair-springs of watches, in which the metal attains a far higher value, weight for weight, than that of gold itself." The same writer adds that "no other material is so enhanced in price by the valuable qualities imparted to it by labor. A bar of iron worth \$5, is worth \$10.50 when made into horseshoes, \$55 in the form of needles, \$3,285 in penknife-blades, \$29,480 in shirt-buttons, and \$250,000 in balance-springs of watches."

Look around you, within doors and without, and mark the universal prevalence of this wonderful substance. Note the cutlery of every shape, and sort, and purpose—the furniture from kitchen to parlor, the house itself. Survey your own persons and select the garment, large or small, which has not received the touch of iron. Pass now into the street and look upon the great city; what is there that has escaped its contact? The stones of the sidewalk, and of every massive edifice—every window, and door, and sign, and lamp-post, and ornament, and merchandise—iron is either there or has been there. Glance at the ten

thousand vehicles, from the humblest cart to the lordliest chariot, survey every harness, and every horse's hoof; what of all these separate from iron? Mount the cars, and fly over the country. But, as you ride, what is at your elbow, overhead, before, behind, beneath? and what is the appropriate epithet of that mighty "horse" at whose heels you are rushing as if "on the wings of the wind?" Pause at the farm-house, and glance at plow, and harrow, and hoe, and rake, and pitchfork, and crow-bar, and shovel, and scythe, and mower, and reaper, and thrasher, and winnower, and all the rest, and then ask the prosperous farmer what he would do but for iron? Ask the same of every mechanic, every manufacturer, every tradesman, every teacher, every author, every soldier, every ruler, and if there be any other occupation or profession, useful or otherwise. Propose to yourself a foreign voyage, and go aboard ship. But you never would venture away to sea unless satisfied that your ship had within itself the unyielding strength which iron alone can insure.

But enough. It is a trite observation to say that of all the minerals embraced in the bowels

of the earth, iron is incomparably the most useful. None is applied to half as many uses, none is used in half so great an abundance.

And right here note carefully another of the divine correspondencies. While, on the one hand, the use of iron is so abundant, the supply, on the other hand, is literally inexhaustible. The earth teems with iron, and its abundance is also widely diffused over many lands. As a partial exhibit of this abundance, I subjoin the report from several countries of the yield of iron for the year 1861, presented at the International Exhibition of 1862. The product in

Great Britain was	3,712,390 tons.
France,	900,000 "
Prussia,	307,400 "
Russia,	250,000 "
Sweden,	215,000 "
Spain,	50,000 "
Italy,	38,000 "
United States,	750,000 "

That is, in these countries alone, six and a quarter million tons of iron were taken from the earth in a single year, and, of course, we may reasonably infer that something like this vast amount was, in an equal time, put to use.

XXXVII.

Coal.



AMONG the mineral treasures of the earth, that which ranks next in importance to iron, is probably *coal*.

Coal is one of the geological formations comprised in the earth's crust, and it exists in the shape of layers of greater or less thickness, and which are termed *coal-measures* by the geologist. It is of vegetable origin, and may be regarded as fossil wood, which, from being long and deeply buried in the earth, has undergone certain chemical changes, and was thus transformed into coal.

As found in our own country, there are three qualities or kinds of coal, distinguished by the epithets Anthracite, Bituminous, and Cannel. Of these, anthracite is the oldest, hardest, and

densest, kindles with more difficulty, but burns *more* the longest, and without flame, and affords the greatest amount of heat.

Bituminous coal is so called from its being charged with bitumen, which causes it to burn more readily than anthracite, and in burning it emits a bright flame, as well as smoke, and a tarry odor. From this, coal oil is extracted, and illuminating gas is manufactured.

Cannel coal is highly bituminous, but of a closer texture than the common bituminous coal, and more easily kindled, but of much less extent.

The *anthracite* coal is produced mainly in Pennsylvania, east of the Alleghanies, while the bituminous coal, commencing west of their *this* mountain range, spreads extensively along many of the States of the Mississippi Valley. These immense coal-fields extend through Pennsylvania, Southern Ohio, Kentucky, Tennessee, into Alabama; another great coal-field occupies the most of Illinois and Western Indiana; still another occupies parts of Iowa and Missouri; another field the central portion of Michigan, while there is also a small coal region in Rhode Island; yet another great coal

area is comprised within Nova Scotia and New Brunswick.

Crossing to Europe we find coal-fields underlying about one-tenth of Great Britain, or nearly 12,000 square miles. In many of the other European countries coal is found, though much less extensively. China, Persia, Hindostan, and several other Asiatic countries produce it in abundance; also, Australasia, and many of the islands of the great Eastern Archipelago.

You may see in the following table the coal areas of this country and Europe:

Great Britain,	11,859	square miles.
Spain,	3,408	"
France,	1,719	"
Belgium,	518	"
British Provinces, . . .	18,000	"
Pennsylvania,	15,437	"
Twelve other States, . .	133,132	"

Thus, in these countries alone, there are nearly 200,000 square miles of coal area, three-fourths of which belong to our own territory.

It is computed that about 150,000,000 of tons of coal are annually dug out of the earth. About two-thirds of this amount is mined in Great Britain, where coal is more extensively used and more highly valued than in any other


part of the world. The amount annually exported from England to foreign countries has exceeded, up to 1850, the entire annual product of American mining ; and it is calculated that the coal-fields of England and Wales could furnish its usual supply, of about eighty or ninety million tons annually, for a thousand years yet to come. But greater things than this could be told of American coal-fields ; to exhaust which it is quite safe to say that more than a million of years would be required.

Such are the riches of coal as well as of iron, two great sister interests, destined to go hand in hand so long as the world shall survive, and to stand among the mighty pillars of an ever-advancing civilization, and of an unprecedented material, intellectual, moral, and national prosperity.



XXXVIII.

Soils.

T is natural, after discarding upon rocks and minerals, to speak of *Soils*, inasmuch as from rocks the several soils are, to a considerable extent, derived. Soils are the daughters of rocks, and come from the disintegration of the latter, the disintegrated materials being mixed with decayed vegetable matter. The process of disintegration is carried on partly by chemical action upon the rocks, by different agencies in the atmosphere, and partly by the wearing action of water either in a fluid or a frozen state. Sometimes the soil of a given locality is formed from disintegrated materials which have been brought by flowing water or glacier action from a great distance, as in the case of what are

called *alluvial* soils, or river "bottom lands," and, also, what are known as *drift* soils. But most soils are found adjoining or overlying the rocks from which they have been produced.

Soils are of very various depths, from a single inch or two to several feet. I speak here of the special soil that affords nourishment to plants. Beneath this occurs an immediate and decisive change, and we come to a stratum of earth, or rock, or both, which is unmixed with decayed vegetable matter, and is, of course, unfitted for the support of plants. This is termed *subsoil*, and is generally of a lighter color than the fruitful soil lying above it. But this barren subsoil may also be made fertile by being turned up and exposed for a time to the fertilizing influences of the atmosphere; and thus it is that many soils, originally thin and partially unproductive, are rendered deeper and permanently better.

Soils comprise about eighteen elements, while yet only *four* of these go to constitute their principal bulk, the others existing in only minute quantities. The four principal elements are *silica*, *alumina*, *lime*, and *humus*. Thus, from silica we have the silicious or sandy soils,

from alumina, the clayey soils, from lime, the calcareous soils, and from humus, the humous soils, these last being made up, in great part, of decayed organic matter, vegetable or animal, or both.

Neither of these several soils, by itself, is best suited to agricultural purposes. The farmer, for instance, delights not in a soil that is "too sandy" or "too clayey." The former, though easy to cultivate, yet often lacks fertility, and is too little retentive of moisture—the rain sinking easily and quickly through it. On the other hand, the soil that is too clayey is heavy and laborious to work, too retentive of water, and thus, under the sun's influence, is prone to become baked into clods instead of dissolving into that mellowness of texture so pleasant to the hand of cultivation.

Thus it follows that, so far as sand and clay are concerned, that soil is nearest to perfection which holds both in proper mixture. Then the facile sand mollifies the stiffness of the clay, while the retentive clay remedies the leakiness of the sand. This mixture of the two soils constitutes what is termed *loam*, and the result is a *clay loam* or a *sandy loam*,

according as the clay or sand predominates. The skillful farmer, in establishing himself, will, if possible, secure both of these soils, and then, as you shall visit him and roam over his harvest fields, you will observe his wheat waving in beauty over the broad clay loams, while the barley, rye, and various root crops overspread the sand loams of the ample domain.

Calcareous soils are sometimes clayey, though more generally sandy, while the *humous* soil is different from either, being of a "spongy and elastic texture," and of a color dark almost to blackness, being composed mainly of decayed vegetable matter. You may, at any time, notice it, as you roam in the woods, where, beneath the fallen leaves, it lies in its perfection, and is one of the richest of all soils.

Various are the modes by which soils are improved and thus rendered more productive, and Science has come in to lend her powerful aid to an improvement so important. The grand desideratum is to ascertain the special lack of any soil in elements requisite for production, and the requisite supplying of those elements. Hence, the proper mixture of soils as above alluded to. Hence, also, the

application of the appropriate manures and in appropriate quantities. Hence, too, *drainage* where water is excessive, and *irrigation* where it is deficient. And so it has, in many an instance, come to pass that a wilderness has literally been turned into a fruitful field, and the desert has been made to rejoice and blossom as the rose.

Nor should my young friends lightly pass over this great matter of the earth's soils. Hence came our varied sustenance, and all those useful and delicious fruits by which we are daily regaled and refreshed. How wonderful as well as benevolent that by the mysterious combinations of a few slight elements and agencies, all this prodigious world of utility, luxury, and beauty is elaborated, advanced, and perfected! Here most marvelously the great God becomes a partner and fellow-worker with man. We are to prepare these soils, plant and cultivate them, and as we do so, he intervenes to spread them all over with the corresponding harvest. "He opens His hand and supplies the wants of every living thing."

XXXIX.

Grasses.



RASS is a general name given to a great variety of plants, and in its largest sense comprehends the several grains, as maize, wheat, rye, barley, oats, rice, etc. These are more generally called the *cereal* grasses, from *Ceres*, the Greek and Roman Goddess of grain and harvests.

What are commonly called grasses in distinction from the above, are such plants as naturally spring up in the field, pasture, and common, and clothe the ground as with a verdant and graceful garment, and forming a sod of more or less firmness. While the cereal grasses seem designed more especially for human sustenance, the common grasses are equally adapted and useful as food for many of

the domestic and wild animals. A few grasses, however, seem to be of little or no use for food, while some are of a poisonous character. Ordinarily, as grasses grow in pasture-lands, several species are found flourishing together; and this is to be placed among the benevolent arrangements of the Divine Providence, that thus provides an agreeable variety for beast, as it has also done for man. The horse and the ox, as they graze abroad upon hill, vale, or prairie, are not, as might be supposed, condemned to a perpetual sameness of food and taste; a pleasant variety is spread out before them as well as for us, and to them, also, it is given to select such viands as may be most agreeable to their palate, or instinctively to feed upon those varieties which are best adapted to their present condition of health.

And flocks and herds spreading themselves abroad over the green pasture-lands, all "receiving their meat from God," present to the eye one of the pleasant scenes of the world. It is one of the innumerable pictures sketched for us in living colors by the great Artist, who "covereth the heaven with clouds, who prepareth rain for the earth, who maketh grass to

grow upon the mountains, who giveth to the beast his food, and to the young ravens which cry."

And equally beautiful is the picture, so often seen, of the more cultivated grasses as they bloom and wave along the rich and fertile meadow-lands. Such are the several clover varieties, the red-top, the prairie, and blue grasses, and especially the timothy, that prince of food-plants for domestic animals, and whose tall stems and ample heads, as they bend and sway before the breeze, remind you of gentle billows gliding over Summer seas. These are the more prominent grasses which the farmer transforms into hay, and lays it up in his store-houses and barns for the Winter food of his flocks when they can no longer graze abroad. Upon this, all along the Winter months, they feed and flourish, sheltered, meanwhile, in their sunny yards from the fierce north-western blasts, or gather within their stalls secure from the wild snow-storm sweeping afar over their forsaken pasture-lands.

"Now, Shepherd, to your helpless charge be kind ;
Baffle the raging year, and fill their pens
With food at will ; lodge them below the storm,

And watch them strict ; for from the bellowing east,
 In this dire season, oft the whirlwind's wing
 Sweeps up the burden of whole wint'ry plains
 In one wide waft, and o'er the hapless flocks,
 Hid in the hollow of two neighboring hills,
 The billowy tempest whelms ; till upward urged,
 The valley to a shining mountain swells,
 Tipped with a wreath high curling in the sky."

THOMSON.

Aside from all ideas of food for man and beast, what would our world be unadorned with this universal, spontaneous, and beautiful carpeting spread abroad by the great, kind hand of Nature's God? Think of one great, bare, bald world, meeting the eye from every direction ; no green spot, no little *oasis* amid the interminable desert, no blade of grass, no leaf or stem or fragrant flower, a wide-spread, ghastly, unsightly *Sahara* from pole to pole ! Such an earth might do for lizards, for hideous and dust-eating serpents, and other reptile monsters, and for ravenous beasts of prey, but man would soon pine, and sicken, and perish there, and so the great Father has made for us a better and more suitable provision.

"He makes the grass the hills adorn,
 He clothes the smiling fields with corn,
 The beasts with food His hands supply,
 And the young ravens when they cry."

Trees.



FROM *grass*, the beautiful carpeting of the earth, the transition is natural to the *trees* with which this same earth is also adorned. Indeed, if the grass may be contemplated as the carpet of this splendid apartment of nature, trees may not inaptly be designated as a prominent part of the *furniture* placed upon its magnificent floor. And who shall adequately picture the superb beauty of these pieces of furniture? A tree! Look at it and consider it well. There it stands in its gay and stately pride, and invites your attention. Suppose you never before looked upon such an object; what would be your sensations—a foundation deeply rooted and firmly intrenched so that the strength of

a thousand hands could hardly disturb it? Thence ascends that tall, straight column, slightly and regularly tapering as the eye follows it upward. There is nothing hollow or spurious, deceptive or weak, in that shaft. A hundred tons might rest upon it safely. Now contemplate those branches springing in each direction from the column. How firmly and intimately are they united with it! How gracefully they curve upward and outward and then downward! How curious and beautiful their own branchings and sub-branchings! How wonderful the foliage overspreading them all! So with all the branches, as, gradually diminishing in size, they approach the summit of the leafy structure. And now, standing at a little distance, glance at the *tout ensemble* of this vegetable erection; contemplate its wealth of foliage, the rich variety in the lines, and curves, and arches of its frame-work, the quiet bending of the thousand branches and little world of leaves as the Summer zephyr breathes softly through them, the unspeakable gracefulness and dignity of the entire aspect and bearing.

This is one of God's trees whereof he has ordered countless millions, and spread them



THE TREE.

lavishly along the earth, and of every conceivable and inconceivable variety; large and small, tall and humble, deciduous and evergreen, fruit-bearing and ornamental, hardy and tender, and if there be any other terms expressive of their countless variations. Sometimes a specimen stands out by itself, solitary and alone like a monument reared in the midst of a plain; sometimes two or three stand up together, as when so many neighbors meet and converse with each other. Sometimes they are grouped in lovely groves of more or less extent; and then, again, they spread out in immense forests, whose dimensions must be measured by leagues, and amid whose somber shades roam the wild beast and savage or barbarian men.

Trees, like the grass which they overshadow, are the spontaneous and normal outgrowth of the soil. Their seeds are everywhere, save in barren deserts, and everywhere, unless prevented, they spring up and occupy the landscape. They form a capital feature of the habitable world, and have done so from the beginning; and they and the green grass comprise the present earth's earliest life. For,

before man or beast began to be, God said, "Let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself upon the earth, and it was so." And the first pair saw, as one of their earliest visions of Paradise, "every tree that is pleasant to the sight and good for food."

And down all the ages trees have had prominent notice, and been especially loved and celebrated, and been intimately interwoven with great events, while with their towering trunks and graceful branches, have been wreathed ten thousand times ten thousand of man's deepest, tenderest associations. Under a palm-tree dwelt the ancient Deborah; and up among its foliage ascended the glad notes of her famous song of victory; while the "trees planted by rivers of water," "the tall oaks of Bashan," "the cedars of Lebanon," "fruitful fig-trees," "trees of frankincense," and the "tree of life," are sources of resplendent imagery in the Hebrew poetry. So also in classic song, and in the modern poetry, as well as in all history, trees have asserted their rightful prominence. Art has attested and imitated their

loveliness, and civilization has lauded their beauty as well as their utility, while taste and culture have ever pointed to them as an indispensable and capital ornament of the perfect landscape. No pleasant home nor garden of delight is deemed possible without their presence ; and their waving forms, and varied music, and refreshing shades are of themselves well-nigh sufficient to transform the unsightly waste into a paradise. Children love and revere their stately forms. Youth and beauty linger delightedly within their grateful shadows, and old age is never weary of sitting beneath those same branches that used to wave above them in younger and brighter days.



Uses of Trees.



F the use and indispensable need of trees as an ornament, we have written sufficiently; but they have other great uses, some of which are entirely obvious to every one. From many varieties, as already hinted, we have fruit in abundance, and “good for food,” as well as delicious to the taste. Nor can there be a clearer proof of the Divine goodness and benevolence than what is furnished in the wondrous variety of fruit-trees, and the variety, excellence, and usefulness of the fruits which they produce for the benefit and happiness of mankind.

Another vital use of trees is the *fuel* which they furnish. Having served their purposes as trees, whether for ornament, fruit, or other uses,

they may be converted into fuel, and thus, besides all the other useful purposes to which fuel is applied, serve to produce in our houses, in Winter-time, the genial warmth of Summer, and create a paradise where otherwise there would be frost and utter desolation. Hence it is not too much to say of trees that their excellence is prominent at all seasons. In Spring-time they delight us by the putting forth of their varied foliage and blossomings; in Summer they refresh us with their grateful shade; in Autumn they present us with an endless variety of fruits; and in Winter they warm our habitations and fill them with gayety and gladness.

So, also, it is hardly necessary to name the immense use of trees for furnishing *lumber* as well as fuel. From trees come the timbers, joists, boards, shingles, etc., which enter into the structure of buildings; and from trees, as a principal material, are constructed vast cities, the myriads of ships that sail over seas, lakes, and rivers, the bridges that span mighty streams, the carriages of every sort that roll along the streets and roads of the world, the fences that, through hundreds of thousands of

linear miles, make the boundaries of public and private inclosures, the foundations over which roll all the locomotives and cars on earth, the furniture adorning the houses and palaces of all nations, and a multitude of minor uses innumerable.


Yet further, trees are of great use—greater than what is generally known and appreciated—for sheltering cultivated lands, and especially the lands devoted to the cultivation of fruits. They present a strong barrier against the rushing in of violent and sweeping winds, often so disastrous to fruits and fruit-trees; and thus they do much to temper the atmosphere and climate of localities over-spread with orchards and gardens, and contribute essentially to their fruitfulness as well as safety.

And trees and forests have much to do with the adequate amount of water for the proper moisture of the soil, and the production of crops adapted to the sustenance of man and beast. Forest trees, and the ground which they shade, are one of the sources of evaporation from which rain-clouds are formed. Water falling from the clouds into the world

of foliage much of which is shaded from the sun, and falling also upon the shaded ground beneath, abundant moisture from rains is retained here long after it is dried away from neighboring localities that are cleared of trees and exposed to the sun's rays. Thus the forest often presents a scene of moisture when all is dry and parched outside. Hence, from the immense expanse of moist leaves and branches and land surface, the process of evaporation goes forward as from an extended surface of water, contributing to those falls of rain so necessary to vegetation, and to the bringing forward the fruits of the earth. All this has, in repeated instances, been amply illustrated by the disastrous and almost fatal influence upon cultivated regions of country arising from laying bare large extents of forest lands, and thus exposing them, as well as the rest of the territory, to the rapidly drying influence of the sun's rays.

To the above uses of trees might be added their direct salutary influence upon the atmosphere by aiding to temper any injurious excess of carbonic acid, and probably by other means more subtile and obscure.

Tides.

IDES are the alternate rising and falling of the ocean waters, as well as of rivers and bays communicating with them, and which are nearly on the sea level. The rising of the waters is called the *Flood* tide, and the falling is called the *Ebb* tide. The highest elevation of the water is called *High* tide, the lowest depression, *Low* tide; and the difference between high and low water varies in different circumstances and places. In New York harbor, for example, the mean difference is about four feet, while in Boston harbor this difference is nearly ten feet; at Liverpool, it is $15\frac{1}{2}$ feet; at London, 22 feet; at Bristol, England, 33 feet; in the Bay of Fundy, sometimes 100 feet.

The tides are caused by the attraction of the sun and moon, especially the latter, upon the great ocean of waters. Though the moon is so much smaller than the sun, yet its greater proximity to the earth gives it a much greater attractive force upon the water than what is exerted by the sun. Hence, the great *Tidal Wave*, so called, accompanies the moon in its circuit round the earth, every twenty-four hours and fifty minutes. The great elevation of the waters, however, is not precisely under the moon, but, owing to their friction inertia, the tidal wave or swell lags somewhat behind the moon's progress, and thus may be said more properly to *follow* than to *accompany* her on her course. The difference of time between that of the moon on a given meridian and that of the summit of the tidal wave coming under the same meridian, is from two to three hours.

Within the space of twenty-four hours and fifty minutes there are two high and two low tides, instead of one of each. If it is high tide, for instance, at Sandy Hook this morning at 6 o'clock, it will be high tide there again at twenty-five minutes past six this evening, and again to-morrow morning at fifty minutes past

six. You will ask how this can be when the tides are principally caused by the moon's attraction of the waters, and when the moon passes over them only *once* instead of *twice* in the twenty-four hours and fifty minutes? This is because there is always a high tide at the same time on opposite sides of the globe. Hence, soon after the moon is over Boston, it will be high tide there, and a little more than twelve hours afterward, when the moon is *under* Boston, it will be high tide there again. Two causes seem to operate to produce this phenomenon: first, that when the moon is over Boston, it not only attracts the waters to a certain degree, but it attracts the whole solid earth, though to a *less* degree. This tends to withdraw the land measurably from the water on the opposite side of the globe, thus rendering the water deeper, or causing a high tide there. It is supposed, also, that this opposite high tide is aided by the greater centrifugal force operating there by the revolution of the earth upon its axis.

The tides are not always equally high. On the contrary, twice a month there are two tides unusually high, and two unusually low;

THE TIDE.



and they occur on this wise. At new moon, you have noticed that the sun and moon are in the same direction from the earth, and, consequently, their attractive force upon the earth is harmonious ; that is, they draw in the same direction, and, of course, with their combined force. This combined force always attracts a heavy tidal wave, and, on these occasions, the tide is two feet higher at New York, and at Boston more than three feet higher than the usual tides. A similar phenomenon occurs a fortnight afterward when the moon is full, and is in opposition to the sun. On the other hand, when the moon is at her first and third *quarters*, the sun and moon drawing at right angles with each other, and the force of each, consequently, hindering instead of helping the other, the tides are then lowest, and are called *Neap* tides.

As we have noticed above, bays and rivers, in numerous cases, are affected by ocean tides, being alternately filled and emptied every twelve and a half hours. Rivers that are affected by the tides are seen to change their current once in six hours, flowing up as the tide is rising, and down as it is falling. Thus

the Connecticut River is influenced by the tide as far as Hartford, and the Hudson as far as Albany; while the great tributaries of the Mississippi never meet the tide, and the main river itself, with its world of waters, seems scarcely to feel its influence. As you might suppose, high and low tides are always later in bays and rivers than the ocean tides, the difference of time being, according to circumstances, from one to several hours.



Rivers.

WE have before written touching the great ocean of waters that is computed to cover nearly three-quarters of the globe. Also, we have noticed that evaporation, constantly going on from this vast water surface, forms clouds in the atmosphere, which, being drifted by the winds over the land, fall in the shape of rain. A portion of the water thus falling upon the ground sinks to considerable depths until it reaches a stratum of the earth, or some rocky bed, which it can not penetrate, and thus are formed those underground pools and reservoirs which are the sources of innumerable springs and fountains. Another portion of the water that falls to the ground from the clouds flows off in

the shape of brooks and rivulets, great numbers of which, running into a single channel, form a river, while this, continually receiving tributary streams from right and left as it goes on its downward course, often becomes a deep and mighty stream, sufficient to float large vessels, and finally flows into the ocean. This great water operation is going on without a moment's cessation over the globe, like as, in animals, the blood is perpetually issuing from the heart and returning to it again.

The great rivers of the earth, in most every case, have their origin among the lofty mountain ranges. Thus the Amazon, Orinoko, and La Plata, of South America, commence among the Andes; the Missouri, in the Rocky Mountains; the Indus and Ganges among the Himalayas, and the Danube among the Alps. Some famous rivers, however, begin immediately from lakes of which they form the outlet. Thus the Mississippi starts from Lake Itasca, the St. Lawrence from Lake Ontario, the Rhone from Lake Geneva, and the Jordan from the Lake or Sea of Tiberias.

Rivers have ever been esteemed among the interesting and beautiful features of the earth.

In fact, no landscape, however attractive otherwise, seems to be perfect, in which water scenery, either river or lake, is wanting. A valley stretching between lofty highlands is often beautiful; but it is doubly so if, perchance, a gentle river is seen meandering through its pleasant groves and verdant meadows. So, also, rivers are useful as they are beautiful. If navigable, they afford channels of commerce from one country to another, or between different and distant parts of the same country. Consider the vast commerce floating upon the Mississippi and its numerous and ample tributaries. On the other hand, when navigation is obstructed by falls or rapids, there is often presented eligible opportunities for water-power operating numerous manufactories of every desirable and useful product. Yet further, rivers conduce largely to fertilize those regions of country through which they flow, bearing along with their waters, and mingled with them, prodigious amounts of rich soil, which, in the frequent overflow of their banks, they deposit upon the lands on either side, rendering them among the most fertile and productive in the world.

In some instances, these overflows are annual, as in the case of the Nile, the Ganges, parts of the Mississippi and its tributaries, and innumerable other streams. The serpentine and winding course characterizing most rivers greatly assists in extending this advantage, as they thus traverse a much wider extent of country and multiply their fertilizing influences accordingly.

So interesting and ornamental are they that we need not wonder that rivers, as well as mountains, are often alluded to in the Holy Scriptures. The first Paradise was not without its rivers, and the second Paradise is pictured to us as adorned with the river of the water of life; while the Hebrew poetry sings of a river the streams whereof make glad the city of God.






THE RAPIDS.

XLIV.

Cataracts.

IVERS often move with a calm, full, and uninterrupted current. But this is far from being universal. Sometimes, in their passage toward the ocean, the waters come to an inclined plane, down which they rush with great velocity. These are called *Rapids*, and form a dangerous pass for boats, though often descended thus where the water is sufficiently deep.

Then again, rivers, in many instances, pour over precipices extending entirely across the streams. These are called *Cataracts*, and some of these, by reason of their magnitude, are counted among the wonders of the world. One of the most remarkable of cataracts is our own Niagara, and, consequently, a few

words about this may suffice mainly for the whole.

Niagara Falls, as you know, occur in the great river of the same name, joining the two lakes, Erie and Ontario. This river is between thirty and forty miles in length, and about twenty-three miles down the stream from Lake Erie is the great cataract. The river is full, and flows calmly onward, and as you glide peacefully down the stream it might be one of the last and most unlikely thoughts in your mind that you were approaching the brink of the most awful cataract on earth. But presently the boat is urging ashore, and none too soon; for, as you glance down the river, you see, at the distance of apparently only a brief mile below, the mists towering up from the cataract, and the rapids are about to commence. Woe to him who, for a single yard, glides over their crest and begins the hideous descent! He is now drifting swiftly along, and it is extremely doubtful whether he will ever reach either shore. The rapids commence, it may be, about a mile above the cataract; and here the great river widens and becomes an expansive, disturbed, and swift-descending sea of waters.

A quarter of a mile, more or less, above the cataract, this rushing sea is pierced by an island, which divides it unequally, pushing the smaller division toward the right, and the larger toward the left. This island extends fully down to the cataract, and its lower end forms a part of the huge precipice, which, by an irregular line, extends sheer across this mighty river, and over the whole of which, except the end of the said island, the great flood was plunging, roaring down forever. *goes*

From the right or American shore, and some rods above the fall, a bridge passes to the island, planted directly over the rapids, by what engineering process, as, in these sketches, I am dwelling with Nature alone, it becomes me not now to inquire. Tread softly on that bridge, as, on your visit to the cataract, you shall cross it and look down, meanwhile, upon the wild, swift, dashing floods rushing beneath your feet. No harm if, as I did, you cross nimbly; for the difference of a moment, on some river and mountain passes, has been as important as life and death. And in returning, no harm if, as I did, you determine to tread those planks nevermore. And when upon the

island, tread carefully there also. Go not too near those fearful shores, for there is no pleasant beach, no calm and quiet eddy, no retreating tide. The banks are full forever, and the waters are rushing by as if madly bent on destruction itself. Keep back from touching them with hand or foot. Once topple over and all is lost. Beware, also, of one or another little stream meandering swiftly from above through the island. I still hold in painful memory that dear little girl whom a senseless youth once held sportively over such a rivulet until she slipped from his hold and fell. In his mortal agony he plunged in to rescue her, but the current was swift and the passage brief, and both were lost.

Of the great cataract itself, it has impressed me that little can be said in the way of effective and satisfactory description. There it is; a great river tumbling over an enormous precipice, which, including the island precipice, may be a mile across. The island divides the cataract; the American division being more than a thousand feet wide, and the other or Canada division more than two thousand. The former descends one hundred and sixty-four

feet, the latter ten or fifteen feet less. The American division, though not half so wide, nor, at its crest, half so deep, is yet a more finished cataract, as it respects the eye observing it. It rolls over on a line nearly straight ; its depth of water is not such but that it can break in descending into a sheet white, vast, and glorious. Also, the entire descent is visible and appreciated. The crest aloft and the base below are both naked to the eye, and the whole is before you as from a mountain summit an approaching storm-cloud is visible from zenith to horizon.

Different is the other and greater fall. The line of its crest is an irregular curve—its apex up stream, and nearer to the island than to the Canadian shore. Within this awful curve is the great flood, and as it rolls over and down it looks deep, very deep ! how deep no human being has ever measured or ever will. Here there is no breaking or ruffling of the ponderous mass, but it goes over calm and smooth, as if an enormous precipice of solid glass were stretched aloft before you, and the water has the hue of no other water, for no brilliant meadow-land, in its fresh and verdant garb of

May, was ever greener. A stupendous flood, arched, green, massive, quiet, is there—quiet we say, for, strange to tell, there is this seeming and aspect as you gaze entranced. That enormous flood is rolling down forever, but, if I see aright, there is no hurry, no rushing, no raging and tearing as up among the mad and sweeping rapids. Another genius and scenery are here. No mere river is pitching itself furiously down. An immense gulf, rather, profound and measureless, is forever rolling in and settling with dignity into the abyss. Nor is it seen, as with the other fall, whither goes this great, green flood, into what caverns it pours, on what rocks it dashes down. A dense and eternal mist comes up to hide those dark depths from every human eye, and no hapless ones that, by sore disaster, have gone down there were ever seen again.

After the falls the Niagara River changes entirely. The path thence to the lake is at the bottom of a deep ravine or cañon, one hundred and fifty or two hundred feet perpendicular, and thus it finds its lone way into the bosom of the Ontario.

A single view of the Falls of Niagara is

desirable, but, with myself, one view is enough. Many tell of exceeding beauty there, and it may be so, but we mistake if that entire scenery be not more grand and awful than it is beautiful. Fear and dread, as it seems to me, are the inevitable as well as the more appropriate emotions. Grand are those mighty waters, but they are wild and terrible withal, and danger lurks there, and death is near. Give me to linger, rather, in the neighborhood of more peaceful, quiet waters, waters that may be touched and loved, whose voice is "still and small," rather than tremendous and awful, and along whose gentle bosom and quiet shores the graceful barge may bear me gently and safely. "He maketh me to lie down in green pastures; he leadeth me beside the still waters."



L a k e s.



IN a preceding sketch I alluded to *Lakes* as one of the sources of rivers, and a general view of them must not be omitted.

Lakes are, as you are aware, bodies of water surrounded by land, and are of all sizes, from the pond of a stone's-throw across it to a sea-like expanse spreading itself scores and even hundreds of miles in extent, and over which, as over oceans and seas, the wings of commerce are flying in every direction.

The Caspian Sea, lying between Europe and Asia, is, by far, the largest lake in the world; being nearly eight hundred miles long, and having an average width of two hundred miles. So spacious is this lake, or sea, that were all

the other lakes of the globe poured into one they would form a lake only about one-fourth larger than the Caspian. Unlike most other lakes, it has no outlet, thus seeming to be a little ocean of itself.

The next largest of the lakes of the globe is our own Lake Superior, being of far less dimensions than the Caspian Sea, yet about as large as the State of Maine. It is the chief of the system of great lakes dividing the United States from British America, Lakes Michigan and Huron being about two-thirds as large as Lake Superior, and Erie and Ontario about one-fourth of its dimensions.

Either of these great bodies of water, as you stand upon its shores, has much the appearance of the ocean, stretching away before you like a limitless sea of waters, beyond which you look in vain for land. A great inland commerce traverses these waters, bearing the products of a widely extended country, and one of the most fertile in the world.

Aral, of Tartary, east of the Caspian, is the third lake in size, being nearly equal to Lake Superior. This, as well as the Caspian, has no outlet, but otherwise is not remarkable.

Of the notable lakes of the world, one of the most curious is *Lake Titicaca*, of South America. It is one hundred and sixty miles long by fifty wide, and is situated far aloft among the Bolivian Andes, its surface being nearly thirteen thousand feet above that of the ocean. No other such a large body of water, at so great an elevation, exists upon earth; and along its eastern shore, and at that great elevation, and well-nigh inaccessible, dwell a million of people. Here seems to have been the seat of the highest and most ancient civilization of South America, and the dwelling-place of a people who have left gigantic monuments of their power and skill.

While the above is the highest considerable lake on the globe, the lake called the "*Dead Sea*" is, as I have before noticed, the lowest of all, for its surface, instead of being above the ocean level, is 1,312 feet below it, and 14,158 feet lower than the surface of Lake Titicaca. This is the deepest depression, probably, on the surface of the earth, and the extent of the lake or sea is, in length, forty-two miles, and in the greatest width, ten miles. Barren hills, from 1,500 to 2,500 feet high, overlook it

on both sides ; intense heat, in the dry season, prevails ; hot winds sweep over the lake, blistering the hands and face ; swarms of mosquitoes torment the traveler to madness ; while, altogether, it is doubtless one of the most desolate and God-forsaken of all terrestrial localities. The waters of the lake are the densest and at the same time the saltiest in the world ; nor is it known that any animal inhabits them.

Into this dreary lake comes down the famous river *Jordan* from Lake *Gennesaret*, measuring, in its meanderings, about two hundred miles between the two lakes, although the direct distance is but about sixty miles. The Gennesaret itself is between 400 and 500 feet below the sea level, and, of course, the Jordan, with its valley, is all a deep depression, hundreds of feet lower than the bed of any other river.

We have remarked of the Dead Sea that its waters are salt ; and this is characteristic of all those lakes having no outlet. Such are the Caspian and Aral Seas, although the waters of the latter are but slightly salt. This phenomenon of saltiness is supposed to be owing to the impregnation of the water by certain mineral substances with which the water comes in

contact, and as there is no withdrawal of the water except by evaporation, which leaves the salt mainly behind, such lakes become permanently saline.

The smaller lakes of the world are innumerable, and go to form a prominent and pleasant feature of thousands of lovely landscapes. Our own country abounds with such, of which the Oneida, Seneca, Canandaigua, Cayuga, George, Champlain, and a hundred others are examples.



Springs. (I.)



SPRING is a current of water coming from the ground and issuing out at its surface. It is a common phenomenon, especially in uneven and hilly regions of country. The water thus issuing from the earth comes from some receptacle or reservoir of water situated under ground higher than the spring, and between which and the spring is a channel of communication more or less perfect. If the communication between the reservoir and the spring were unobstructed, as though the water were flowing down through a full pipe, then, if it issue from a suitable aperture, the spring would take the shape of a jet or fountain, and the water would spout into the air to a height approaching that of the

subterranean reservoir. But whence these hidden reservoirs? They are cavities which have been probably formed by the agency of water. In the case of rain-fall, as we have before noticed, a part of the falling water flows down descending surfaces of the ground, forming rills and brooks flowing off into larger brooks, and these into rivulets, and these into a river. Another portion of the raining water assumes, however, a different course. Instead of running off on the surface and forming surface streams, it settles into the ground to a greater or less depth, according to the character of the soil through which it percolates. If there is much sand beneath, the water will settle to a lower depth; if there is a strong mixture of clay it will sink a less distance. If the water encounters a surface of stone or hard clay its vertical sinking will, of course, be arrested, and if the hard surface be *shelving* it will find its way over its lower side. On the other hand, if the rocky or clayey surface is hollow and somewhat extensive, a large amount of water, in settling down from the surface of the ground above, will be detained until, at some point lower than the others, it will overflow

and seek a downward passage away from the reservoir ; and if a way opens out to the surface a spring will be formed. Sometimes the passage from the reservoir to the spring is very short, as is doubtless the case with springs so frequently seen at the base of hills or gentle ascents. In other instances, the reservoir whence the spring water comes is miles away.

Springs are diversified in their character. Some are feeble, from which but a slight stream issues ; others burst forth with a volume of water sufficient to operate a water-wheel for mechanical purposes. Some are intermittent—alternately flowing and ceasing to flow—others flow on without interruption. Some waters, in passing from the reservoir to the spring, journey mainly through depths of sand or through sand-stone rocks, and thus come forth to the surface soft and pure ; others take their course through very different strata, extensive limestone regions for example, and such spring water, holding more or less of lime in solution, will be calcareous, or “hard.” While most springs are cold, some, especially in volcanic regions, are hot springs ; and some are hot and at the same time intermittent, like the Geysers

of Iceland. Some, again, are *mineral* springs, their waters being slightly impregnated with mineral substances through which they have passed.

Springs and fountains have ever been a welcome and attractive feature, and are highly conducive to beauty as well as utility. One of the capital excellencies of the Land of Promise was that it would be "a land of brooks of water, of fountains and depths that spring out of valleys and hills."

It may be added that subterranean reservoirs and streams issuing from them are almost every-where, though multitudes of such streams fail to come to the surface and form springs and fountains there. In most cases we have to go beneath the surface to encounter these streams, and when, in sinking our shafts, we come upon them, the water flows in at the bottom, a permanent spring, though deep in the ground instead of being at the surface like other springs. This we call a *well*, and we esteem it next in value to springs issuing from the surface; while in all ages wells, as truly as springs and fountains, have been celebrated and have their place in the history of the race.

Thus it is one of the many noticeable facts of our earth, that its crust, down amid all accessible depths, is charged with water, and generally such water as, in its nature and qualities, is adapted to the appetite and wants of man and beast. Hence, for this vital necessity of ours, we are not dependent upon every transient and varying cloud above us. It is not to the clouds that we resort for cooling and refreshing waters. Magazines, immense and inexhaustible, are always beneath our feet, sometimes springing up to meet our thirsty lips, or else only requiring that we say, as did the Master at the ancient well, "Give me to drink."



XLVII.

Springs. ^(2.)



UR preceding letter closed with a vision of the Savior at the well of Sychar. This circumstance, associated with his conversation there with the woman of Samaria, reminds me to notice the splendid source of sacred imagery furnished by Springs, Wells, Streams, and Fountains of water. Will you indulge me with a slight glance at a specimen or two before passing on to another theme? And let us contemplate one of the modes whereby, in the Holy Scriptures, man's great want and its supply are imaged forth.

Are we, by nature, morally impure—from the sole of the foot to the head, unclean—altogether become filthy? “Then will I sprinkle clean water upon you, and you shall be clean ;

from all your filthiness and from all your idols will I cleanse you."

Are we longing for a purer, higher, and holier life? "Let him that is athirst come. And whosoever will, let him take the water of life freely." "Ho, every one that thirsteth, come ye to the waters." "If any man thirst, let him come to me and drink." "I will give unto him that thirsteth of the fountain of the water of life freely." "They have forsaken me, the fountain of living waters."

Do the purest, best, and most reviving of earthly fountains fail to give permanent life? And drinking these, shall we still often long to repeat the draught, and die at last? "Whosoever drinketh of this water shall thirst again; but whosoever drinketh of the water that I shall give him shall never thirst; but the water that I shall give him shall be in him a well of water springing up into everlasting life."

Need we consolation and hopeful assurance in passing through this vale of tears? "With joy shall ye draw water from the wells of salvation." "There is a river the streams whereof shall make glad the city of God."

Shall a good man flourish and prosper in the

earth? "He shall be like a tree planted by the rivers of water, that bringeth forth his fruit in his season." "As a tree planted by the waters, and that spreadeth out her roots by the river, and shall not be seen when heat cometh." "Thou shalt be like a watered garden, and like a spring of water whose waters fail not." What of them that hearken to God's commandments? Their peace shall be "as a river, and their righteousness like the waves of the sea."

Shall a man do great good, and become a source of large and numberless blessings to his race? "He that believeth on me; out of his belly shall flow rivers of living water."

Does the good man anticipate a second paradise, beautiful as Eden, and much more abundantly so? "And he showed me a pure river of water of life, clear as crystal, proceeding out of the throne of God and the Lamb. In the midst of the street of it, and on the side of the river, was there the tree of life, which bare twelve manner of fruits, and yielded her fruit every month; and the leaves of the tree were for the healing of the nations. And there shall be no more curse."

AT THE SPRING.



XLVIII.

Water.

BUT what is Water? Having written of it so repeatedly as it appears in the seas, rivers, lakes, springs, and fountains, and familiar as we are with its beauty and its multiplied adaptations to the wants of the animal and vegetable world, a word or two touching its nature and properties seems desirable.

Water is composed of two gases—Oxygen and Hydrogen—chemically combined in proportions, by measure, of two of hydrogen and one of oxygen.

Of water there is a multitude of varieties from that which is pure to what is greatly the reverse. In respect, however, to water absolutely pure, it may be doubtful whether such a

thing exist in nature. Rain-water, which is the purest, is yet not entirely so, evaporation from the ocean always carrying with it a certain amount of salt. Nor does distillation insure absolute purity, though many times repeated. All this seems no special damage, nor, for the most purposes, would water be improved by being rendered absolutely pure. For drinking purposes, it would thus become insipid and tasteless; and thus it is that the purest rain-water is not so agreeable to drink as the water from wells or springs. The latter, by percolating through different mineral substances, in its way through the ground, acquires a slight degree of taste which makes it more pleasant to the palate than water directly from the clouds. The impurity of water arises mainly from its solvent power, which is very extensive, most substances coming in contact with it being more or less subject to its influence. This is the secret of all *mineral* waters, some of which are so salutary in their effects upon certain diseases, while others are deleterious.

“A good drinkable water,” says an author, “may be recognized by the following characters: it is perfectly colorless and transparent

without smell or appreciable taste, but agreeable, and not insipid or flat, does not lose its clearness by boiling, and leaves a very slight residuum upon evaporation." The same writer adds that "rain-water, not of the first fall, and the water of thawed snow and ice, are, of course, purest of all that offer for common use, and no others are really so well adapted as these for culinary, cleansing, and mechanical purposes. But the lack of gases in these waters, unless they are artificially aerated, as by agitating them with air or other gases, render them less agreeable for drinking."

Of the abundance of water I have already written. Its proportion of surface on the globe, compared to the land surface, is as 276 to 100. On that part of the globe north of the equator, the proportion is as 150 to 100. In the southern hemisphere it is as 628 to 100.


Great as is this apparent disproportion of water on the earth it, nevertheless, seems harmonious with its countless uses and necessities. Instead of asking, where are these uses and necessities? we may more properly ask, where are they not? In what operation of

nature or art can it be dispensed with? What would the air be without its presence? What would become of the soil and the whole vegetable world, without its solvent and nourishing qualities? Equally, what would become of the whole animal creation? What become of all art, all manufactures, all commerce, all water and steam-power, all transportation? The water-power of the streams of Europe alone has been computed to be equivalent to the power of more than three hundred and fifty millions of horses incessantly working by day and night. Water seems to us a simple thing, yet it is as great as it is simple, as desirable as the comeliness and beauty of this magnificent globe, as useful as the vital air, or our daily bread, as necessary as life itself.



XLIX.

Clouds.

AVING written so much of water in its various forms of seas, rivers, lakes, springs, and fountains, let us glance, for a moment, at the immediate source from which we receive it. That source is the *Clouds*. But what are the clouds? I have already alluded to the subject of evaporation; which means the ascending of vapor, that is, minute particles of water, from the surfaces of water and land. This operation is going forward at all times, and the invisible vapor is continually ascending, though at some times much more rapidly than at others. The vapor ascends into the air, which has a vast though limited capacity of retaining it, this capacity, in a given region, varying according to its

temperature. The warmer the air into which the vapor ascends, the more the particles of vapor expand, and expanding continue to ascend. On the other hand, cold air condenses the particles, and thus they become visible in the shape of a cloud. It will be a thin cloud if the air is but slightly cool and not too much charged with vapor, and by a slight change to a warmer temperature, the cloud disperses again and becomes invisible. Or, if the air is highly saturated with vapor, and is sufficiently cool, a heavy condensation takes place, the particles of vapor collect in drops, and being then too heavy to remain aloft, they fall in the shape of rain. Thus the same cloud may shed its water in rain or be dissipated into the upper air, according to the temperature of the region of the air where the cloud is resting. If cool and growing cooler, there will be rain; if the air becomes warmer, either by the sun's rays, or by the cloud being driven by wind into a warmer atmosphere, it will be scattered and probably disappear; or should the wind waft the same cloud against some lofty mountain, the cooler air will cause rain. Thus it is that the clouds are ever changing their form, now

enlarging and darkening, and, perhaps, giving out rain ; then, again, brightening, diminishing, and entirely disappearing—an emblem of our present uncertain existence. “For what is your life? It is even a vapor that appeareth for a little time and then vanisheth away.”

Philosophers have assigned names to the clouds according to the different aspects which they present to us. The *Cumulus*, for example, is the Summer-day cloud, having the appearance of distant rounded hills covered with snow, often increasing with the warmth of the day, obscuring the sun, and sometimes condensing into rain.

The *Stratus* is rather a night and Winter cloud, appearing in the horizontal layers or strata sometimes suddenly produced, hangs lower than other clouds, and, in Winter-time, not unfrequently shuts out the sky for several successive days.


The *Cirrus* has a feathery aspect, extends “in long, slender filaments, and, again, in parallel stripes, from one extremity of the heavens to the other.” It is a very elevated cloud, appearing from lofty summits as high in air as when seen from the plain.

These three main forms of clouds often, of course, blend, more or less, into each other, producing intermediate forms ; and when confusedly intermixed the mingled mass is called *Nimbus*, which is more especially the rain cloud.

The clouds present to us another deeply interesting subject of contemplation, and they have, in all ages, attracted the attention and study of man. And no wonder ; they are aloft, and conspicuous, and often beautiful and greatly welcome, and, at times, too magnificent and grand for description. From them come the riches of the rain and snow, and by their different aspects we learn to predict, with greater or less certainty, the coming on of storms, or the advent of fair weather, or the approach of colder or milder hours. Also, they are the arena of that great artillery whose thunderings are heard afar as their awful echoes rattle athwart those fields of air, or break with deadening, frightful crash just before or behind us.

L.

Rain.

FROM the clouds comes *Rain*, which is a condensation of the vapor in the atmosphere into drops, whose weight causes them to fall to the ground. As has been already said, when, by any cause, the air becomes suddenly chilled its capacity for holding moisture is diminished, and the excess becomes condensed, and the rain-drops are formed.

As rains are governed very much by the state of the atmosphere, it follows that the amount of rain-falls in different parts of the world vary exceedingly. The torrid zone is especially subject to rain. Here the Trade-Winds from the north-east and the south-east meet under the equator, and bring in from the

oceans over which they pass immense quantities of vapor, and as the atmosphere is intensely heated by the sun it becomes saturated to its utmost capacity by vapor; hence, the abundant vapor is borne upward to higher regions of the air, where becoming cooler and condensed, it falls back in abundant rains. Also, in these regions, and owing to frequent changes of temperature, violent tornadoes and thunder tempests are almost daily occurrences. This "belt of rain," or rainy season, follows the sun as it traverses from the north to the south tropic and back again, so that, in the torrid zone, it occurs twice a year, and the amount of water that falls in the course of a year is almost beyond belief. Humboldt estimated the average depth of rain falling annually in different latitudes as follows :

At the equator,	. 98 in.	Latitude 45 deg.,	29 in.
Latitude 19 deg.,	80 in.	Latitude 60 deg.,	17 in.

While this average proportion for different latitudes may be nearly correct, yet certain localities of the torrid zone vary exceedingly from such an estimate. At Paramaribo, for example, in Dutch Guiana, the annual rain-fall amounts to 229 inches; at Maranhao, Brazil,

to 276 inches; at Guadaloupe, to 286 inches; at Mahableshwur, to 302 inches—25 feet!

Rains in the temperate zone are more irregular, and a much smaller quantity of water falls. The average yearly amount for several localities has been ascertained to be nearly as follows:

British Isles,	32 in.	Western Reserve, O.,	36 in.
France,	24 in.	Ft. Crawford, Wis.,	30 in.
Germany,	20 in.	Philadelphia,	45 in.
Hungary,	17 in.	Marietta, O.,	41 in.
Eastern Russia,	14 in.	St. Louis, Mo.,	32 in.
Cambridge, Mass.,	38 in.		

In the temperate regions the mean annual amount of rain in the Eastern Hemisphere is 34 inches, in the Western Hemisphere 39 inches.

Enormous rains sometimes occur in certain localities. In February, 1820, at Cayenne, of French Guiana—which appears to be the *rainiest* country on earth—there fell in twenty-four days twelve and one-half feet of rain! a quantity one would think sufficient to flood the country, and sweep to destruction every habitation.

On the other hand, strange to tell, there are extensive regions of the earth where no rain

falls. Most of such countries, of course, except where irrigation is possible, are *deserts*—waste places of the earth where no green thing is seen. Such is the great Sahara of Africa; such, also, are much of the Asiatic countries of Arabia, Persia, Thibet, and Mongolia. On our own continent, the narrow territory between the Andes and the Pacific is, much of it, a desert. Also, Western Mexico, extending northward into Arizona and Nevada, may be classed among the desert regions of the globe. These are rainless, cheerless countries, most of them unfit for the residence of human beings, and comprising not less than seven or eight millions of square miles of the earth's surface. This is a serious amount withdrawn from the fifty millions of the earth's solid surface. Why so great a waste? Why not afford the rain here as elsewhere, and turn these immense deserts into fruitful and habitable countries? I can not answer; God knoweth. He thus orders and arranges, and all his ways are the best possible. Let us rest the matter there, for there is abundance of goodly land yet to be possessed, and of which it may be said, "Thou visitest the earth, and waterest it;

thou greatly enrichest it with the river of God, which is full of water; thou preparest them corn, when thou hast so provided for it; thou waterest the ridges thereof abundantly, thou settlest the furrows thereof; thou makest it soft with showers, thou blessest the springing thereof."



D e w .



FTER all, however, the desert lands are not all of them utterly desolate, for, though rain is withheld, the *Dew* comes in as a partial substitute for some of the rainless localities of the earth. But first let us revert to the origin of dew. As evaporation is constantly proceeding, so the atmosphere is always more or less charged with moisture; thus, let it come in contact with an object cooler than itself, as upon a pitcher of cold water placed upon the table, and the moisture, or vapor, in the atmosphere will be condensed and appear as a fine dew upon the surface of the vessel. By a similar process all dew is formed. It is the vapor of the air extracted by the greater chilliness of the surfaces upon

which the moisture is deposited. Evaporation constantly proceeding at the surface of the ground, this surface is cooled by the process, and the warmer air coming in contact with the cooler surface deposits its moisture upon it; and the point of temperature at which the moisture begins to be deposited is called the *dew point*.

If the air be saturated with vapor, that is, contain as much moisture as its capacity will allow, then, as it comes in contact with the cool earth, there will be what is termed a heavy dew; in other words, a large amount of water will be deposited.

Dew begins to form, often, before the sun has set, and a visible degree of moisture will be observed by walking through the grass. It forms more rapidly, however, toward morning, as the earth then becomes cooler than before.

From the above remarks touching the formation of dew, it is plain that the dew does not fall, as many suppose, but is produced directly where it is seen; and this delusion of the *falling* of the dew was aided with some of us when children, by observing that, after cloudy nights, there would be little or no dew upon

the grass. Thus we not unnaturally inferred that the clouds prevented the dew from falling by their intervention between the sky and the earth. The clouds did indeed prevent the dew, but not in any such way as we supposed. They prevented it by preventing the earth beneath them from cooling; and this was accomplished by the rays of heat from the ground impinging upon the clouds and being by them reflected back again to the ground. Thus the earth, being prevented from losing its heat, retained about the same temperature as the air in contact with it, and hence no moisture from the air was deposited. Not only clouds, but any other overhanging object, as a tree or a piece of cloth stretched out a few feet above the ground, will have the same effect, and so gardeners, to prevent young plants from being touched by frost, sometimes thus prevent them from being bedewed, in order that there may be no dew upon them to freeze.

The amount of dew deposited in some countries is surprising. One author estimates the annual amount precipitated in England to be five inches of water, which is nearly one-sixth the amount that falls in rain. Indeed, on

some mornings, so great is the quantity of dew precipitated in the preceding night that there is the appearance of having been rain instead of mere dew. Thus it is, as I hinted in the beginning of this sketch, that even some rainless countries are saved from being absolute deserts like the great Sahara of Africa. This is true of portions of the western coast of both North and South America, also of Camana in Venezuela, and in upper Egypt, as well as other dry regions of the East. Nor is such benefit of dew confined to partial deserts. In times of drought, not unfrequently occurring in countries favored with rains, the dew is of great service, and though not an adequate substitute for rain, yet the dews often mitigate the severities of droughts, and save the blighted fruits and vegetables from utter failure and destruction.

In conclusion, dews, as well as other forms of water, are honored with pleasant allusions in the Holy Scripture, and have their place in the sacred imagery. "God give thee of the dew of heaven!" said the ancient patriarch as he blessed his son.

Ice.



ICE, as you know, is water made solid by freezing. When water is reduced in temperature down to 32° of Fahrenheit's thermometer it begins to freeze, and hence this is called the *freezing-point*; like as the point where vapor in the atmosphere becomes dew is called the dew-point.

Water, by freezing, expands to a certain extent, so that a cubic foot of water changed to ice would measure more than a cubic foot. This has been thought an exception to the general law of contraction by cold. But it has been ascertained that fusible bodies generally, in a solid state, have a less specific gravity than in a melted state. A piece of solid metal, for example, will float in the same metal melted.

This, at first sight, seems an unimportant fact, and having little to do, one way or another, with the welfare of the world. But suppose that water should follow the general law of contraction by cold. It does, indeed, follow this law down to about 39° , when, as the cold still increases toward the freezing-point at 32° , the water *expands* instead of contracting. If it should continue to contract down to the freezing-point, and ice, as it is formed, should have less bulk than the water of which it is made, the consequences would be disastrous in the extreme. It would then happen that every piece of ice as soon as formed, instead of remaining at the surface of the water, would immediately sink to the bottom of the lake or river, and this process of formation and immediate sinking of ice would continue to go on so long as the weather should be sufficiently cold for freezing. It would follow that in the course of a single cold Winter all such lakes and streams would become solid ice, and would remain substantially so always and in all regions of the earth where the Winter's cold would be sufficient for freezing over the surfaces of such bodies of water. This would, of

course, seriously affect the climate of such countries, and thus not only would all navigation of these waters be arrested and would forever cease, but no small part of the world would become partially or wholly uncultivated and uninhabitable. So much is often dependent in the world of nature upon a single, apparently, unimportant arrangement; while the one before us is the more noticeable and curious, as being an exception to a general law.

After ice is once formed, however, it no longer contravenes the general law of contraction by cold, but as, in extreme cold weather, the ice becomes colder than when first formed, it contracts, like other bodies, under the influence of cold; hence, in this shrinking, the ice on lakes and rivers often cracks asunder with loud reports.

Ice has its uses; for the Creator has ordered nothing in vain. Like snow, which itself is ice, it is a bad conductor of heat; and being formed over rivers and lakes, prevents the heat from below escaping through it, and thus cooling the water to an excessive degree. In the same way it protects land surfaces that the Winter season overspreads with ice. Also, in

the Arctic regions, the natives, with the same view, erect their huts of ice, in which they pass away their long, cold, and dark Winters. And then, too, ice can be preserved into the warm season, and thus it becomes a special luxury amid the Summer heats, as well as greatly useful for the preservation of meats and other articles; hence it has, of late years especially, become a commodity of extensive commerce. For this purpose, as well as for domestic use, it is during the Winter season cut out from ponds and rivers in blocks as large as can be conveniently hailed, and stored *hand* in ice-houses, whence it is shipped to those parts of the world whose climate is too warm for producing it.

This is a recent but rapidly growing traffic, as is evinced by the fact that during the last half century the annual export of the article of ice from this country has advanced from 130 tons to 150,000 or more.

Glaciers.



THE subject of *Ice* reminds us to speak of *Glaciers*, which are, in fact, *rivers* of ice instead of water.

Imagine any river which you have ever seen to be instantaneously changed into ice, from the surface to the bottom of the stream, and you have a correct general idea of glaciers as they exist in vast numbers among the high mountains of the earth.

You are aware that mountains rearing themselves above a certain height, are covered with perpetual snow. You will also recollect that these lofty and immense snow-fields are not mainly smooth surfaces, but are often cut across by wide and deep gorges or ravines scooped down the mountain side from very

lofty elevations. Far up amid these dismal realms are frequent tempests of snows and hurricanes so dense, wild, and terrible, as we who witness snow-storms on the lowlands of the world have little conception of. In process of time, these repeated snows fill up the huge mountain gorges to the depth of hundreds and often thousands of feet. Partly by the prodigious pressure upon these depths of snow, as layer after layer is made, by successive storms, it grows into ice, and thus there is formed an ice river, as already noticed. These ice rivers, or glaciers, may be counted by hundreds within only a few miles along the Alps, extending down the mountain gorges from ten to twenty miles in length, and from one to more than two miles in width, and in many places toward 1,000 feet deep. Commencing, as, of course, they must, up above the line of eternal snow, they extend down the mountains to three or four thousand feet above the level of the sea; at this height they terminate. Far upward toward their beginning, they are covered with the never-melting snows; but down here at their lower terminus, if it is Summer-time, the snows have melted

off, and there stands before you an enormous and ungainly precipice of ice, itself partially melted amid the warmer atmosphere into which it has intruded itself; and thus, by the melting process, it becomes somewhat depressed at the top, and worn wedgewise at the sides, the terminus, however, still remaining, often lofty and inaccessible.

Should you, in ascending the mountains, travel up one of these glaciers, you will find the surface often so rough and confused as to be difficult to traverse. Here a hollow will be scooped out and filled with water, there the ice, for several feet or rods, has parted, and a chasm of unknown depth yawns before you. Sometimes this chasm extends well-nigh across the glacier. Sometimes the opening is straight, at other times curved. Then, again, multitudes of stones, some of them large boulders, are scattered or heaped up and down the rough surface, having fallen from the hideous precipices through which this strange ice-river is passing. These stones and debris, stretched along the glacier, are called *Moraines*, and constitute one of the striking features of the scenery.

THE GLACIER.




As the melting process goes on more and more as the glacier tends down the mountain, numerous channels of water perforate the body of ice, some of them extending down to its very bottom and forming rivulets which issue out from the terminus of the glacier, and become the commencement, often, of far-extending and famous rivers. We have just hinted that these ice-rivers themselves are not stationary, but actually have a motion downward, though so slow as not to be perceptible to the eye. The ice of which they are formed is not what we term *solid* ice; for ice in immense bodies like the glaciers is not the brittle, solid substance we see cut out of rivers or lakes, but is rather, especially when saturated with water, of a partially *plastic* character. Thus this ice of the glacier, having upon it a most enormous pressure from above, has a gradual, but perpetual motion downward. It is, in fact, not only a river, but a *flowing* river. The rate of motion, like that of rivers of water, is governed by the rapidity of descent. If the glacier is nearly level, it travels slowly; if its path is steep, its course is more rapid. Some are known to travel about two hundred and

fifty feet in a year ; others twice as far. They travel faster in warm than in cold weather, and it is noticed that, like common rivers, the middle of the ice-stream has a more rapid motion than the sides and the bottom.



Icebergs.



IN writing about *glaciers*, I remarked that having originated up among the eternal snows, they, in temperate latitudes, flow down the mountains far below the snow limit, to within 3,000 or 4,000 feet above the level of the sea, and there, in the warmer temperature which they have reached, terminate by the gradual melting away of the lower extremity of the ice-river.

Very different from this is the state of things with glaciers that are formed among the mountains of the Arctic regions of the globe. Here the line of permanent snows and frost is no longer far up the mountains, but is clear down to the sea-level. Consequently the Arctic glaciers, instead of terminating 3,000

or 4,000 feet above the ocean-level, flow down bodily to the very shores of the sea, and even push themselves, in the shape of an enormous ridge of ice, into the frozen seas and bays of the extreme North. Here they go plowing and crushing through the thick ice, covering the waters, until the stupendous mass issuing into deep water, and being no longer supported by the solid ground beneath, breaks off from the main glacier, and floats away independently and by itself.

Thus it is that *Icebergs* are born, which, as you probably know, are immense bodies of solid ice, floating about in Northern seas, and often drifting down so far south as to be seen from vessels crossing the Atlantic. Not only are they seen, but they not unfrequently float directly into the pathway of ships, and, especially at certain seasons of the year, form one of the dangers of navigation. A ship under sail in a dark night, striking against one of these awful ice-mountains, would almost infallibly be sunk within a very few moments, in the depths of the ocean; nor is there a doubt that many an unfortunate voyager over the sea has thus suddenly perished with all his

comrades, so that no tidings of their sad fate ever came to the ears of their friends at home. Every year, more or less vessels sail away to sea, and are never heard of more; and we need hardly doubt that some of these were wrecked and lost under the cold and hideous precipices of an iceberg.

The iceberg may be considered an ice-mountain floating in the ocean. Their dimensions, as well as their numbers, are often astonishing. Dr. Kane, in one of his cruises, saw, on one occasion, 280 in sight at once, most of which were 250 feet high, and some more than 300 feet. The dimensions of some must be measured by miles instead of feet or rods. Lieutenant Parry saw an iceberg two and a half miles long, and nearly as wide, and fifty feet high, and it was aground in water 300 feet deep. Dr. Kane saw one aground in soundings of 500 feet. Captain Ross, another Arctic navigator, saw several icebergs aground in Baffin's Bay, where the water was 1,500 feet deep. One was seen in the Southern Ocean thirteen miles long with vertical walls one hundred feet high. And you are to keep in mind the fact that great and lofty as these

ice-mountains are above the surface of the water, you thus see only about one-eighth of the whole mass, seven-eighths being immersed. The force of these stupendous bodies floating freely in an ocean current, would doubtless exceed by far any other force upon the surface of the globe. As they float upon the sea, ice-bergs do not always preserve the same position in the water, but not unfrequently they roll over either partially or wholly. "Nothing," says Dr. Kane, "can be more imposing than the rotation of a berg. I have often watched one, rocking its earth-stained sides in steadily deepening curves, as if to gather energy for some desperate gymnastic feat, and then turning itself slowly over in a monster somersault, and vibrating as its head rose into the new element like a leviathan shaking the water from its crest."

As I have in this sketch repeatedly referred to Dr. Kane, allow me to recommend to you the careful perusal of his "Arctic Researches," as being a book not only full of interest, but as admirably fitted to impress lessons of what a determined and brave man can accomplish in spite of the most formidable difficulties.

Heat.



EAT is a name we give either to a certain sensation or to that something which causes the sensation.

This is about all we can say of it in the way of description. We are familiar with some of its *effects*, but what is the mysterious agent itself no man knows. Its great source, so far as our earth is concerned, is the *sun*, from which emanates an amount of heat far surpassing all human conception. It is computed that the sun sends to the earth and its atmosphere sufficient heat annually to melt a shell of ice a hundred and forty feet thick. But our earth lies off from the sun nearly a hundred million of miles, and consequently occupies but a very small part of that immense sphere

which is filled with the sun's light and heat. Were all the sun's heat that is sent out from its surface in every direction to be directed upon the earth, it would in a single year melt a crust of ice four thousand miles thick, or a crust thirty-seven feet thick every minute; in other words, the sun would pour upon the earth perpetually, a heat seven times as great as the glowing fire of a blast furnace.

So far as we know, heat is universally diffused, being contained in all matter in whatever state, whether gaseous, liquid, or solid. Even ice is not free from it, for transport a piece of ice from our latitude to the Arctic regions, and it would be as much colder there than here as the temperature of the air is colder; that is, the block of ice would have parted with so many degrees of heat. Bear it to some colder region still and, for the same reason, yet more heat will be abstracted from it.

Thus heat differs extremely in intensity or quantity, ranging from a point too low to a point too high to be measured or at all appreciated. By an artificial thermometer, or measurer of heat, we are accustomed to express by figures different degrees of it so far as is nec-

essary for ordinary purposes. By the thermometer principally used—that of Fahrenheit—the point of temperature at which water boils is designated by the number 212, and the point at which it freezes by the number 32, thus reckoning 180° between these two points. Then, by this thermometer, about 51° is the average temperature of London, $81\frac{1}{2}^{\circ}$ that of the equator, $99\frac{1}{2}^{\circ}$ that of human blood, 980° that of red heat, and $1,140^{\circ}$ marks the heat of common fire. By this thermometer the figure 60 denotes a temperate warmth, and 100 a warmth which we sometimes experience in Summer days, but which is quite too great for comfort or health.

Thirty-two degrees being freezing-point, zero designates, of course, very cold weather, while at 15° and 20° below zero we have extreme cold. At 39° below zero the mercury of the thermometer freezes, and thus can indicate no greater cold; hence, for this purpose, instead of mercury alcohol is used, which will indicate a hundred degrees more of cold before freezing.

In respect to the effect of heat on bodies, the general law is that it expands them, while they contract again in cooling; and the force of

this expansion and contraction is well-nigh irresistible, and is not prevented from acting by the magnitude of the heated object. Thus it is stated that the Bunker Hill Monument, a mass of stone thirty feet square at the base and two hundred and twenty-one feet high, is so acted upon, in a bright and warm Summer day, that its top is swayed through an irregular ellipse, returning to its perpendicular position only when all its sides return to an equal temperature.

Heat communicates itself in various ways, as, first, by *conduction*, which is the mode mainly in solid bodies, wherein a particle of matter receives heat from an adjoining particle and gives it out to other adjoining particles; a second mode is by *convection* or being carried—the mode with fluid bodies. A particle becomes heated and immediately moves off, carrying its heat with it, and communicates it to other particles at a greater or less distance; a third mode is by *radiation*, analogous to the transmission through space of the rays of light.


Heat bears a most important part in the constitution and arrangements of our world,

and in every thing and animal upon its surface. All bodies with which we are familiar are incessantly under the influence of this agent, its presence being an indispensable condition toward fitting the world for the habitation of life and intelligence.

Cold is a negative; being simply the absence of heat, as darkness is the absence of light; and, of course, degrees of cold are ascertained by the same instrument as those of heat, that is, by the thermometer; for when the mercury of the thermometer stands at 40 it indicates that there are 40° of heat and the absence of any more than 40° , that is, a cold of 40° . Thirty-two degrees indicate such an absence of heat, that is, such a degree of cold, as that water will freeze. The causes of cold are absence of the sun, thinness of the atmosphere, as in ascending mountains, evaporation, and radiation through a clear atmosphere.



light.

“ND God said, Let there be *Light*, and light was.” Previously, it appears that darkness was upon the face of the abyss, and, in the establishment of the present order of things upon this earth, the Creator made the sun as the great source of the light which we enjoy.

What this light is, as in the case of heat, we are ignorant, and different theories touching its nature have been propounded by philosophers. The Newtonian theory contemplates it as a material substance whose particles are almost infinitely minute. The theory, however, now more generally adopted, is what is termed the *undulatory* theory, maintaining that light is propagated by means of pulses or

waves of disturbance originating, by some means, at the surface of luminous bodies, and spreading thence in every direction.

If there is more or less uncertainty as to the nature of this wonderful thing which we call *light*, yet some of its properties are well ascertained. We know, for example, that it *travels*, and the rate of its progress through space. We know also, that, in a homogeneous medium, it travels, so to speak, in straight lines or rays. We know that in passing from a rarer to a denser medium or the reverse, the straight rays of light are bent according to a certain law. We further know that rays of light are capable of being *reflected* as well as bent, and, as in the case of a reflected ball, the angle of incidence and of reflection are equal ; and we know that as the rays of light are capable of being bent from a straight line so they can be gathered and converged to a point or focus, or, on the other hand, can be dispersed and scattered. Still further, we know that light, in its progress, can penetrate and pass through certain solid and liquid substances, as glass, water, etc., while other substances either reflect or absorb the rays of

light impinging upon them. And we also know that light is the source of colors, and is the blending of all the several hues and tints that exist. We know, too, that light exerts a special influence upon vegetation and is essential to it.

As light does not diffuse itself instantly, but progresses through space, its rate of progress, as was noted above, has been ascertained. Thus it is known that light travels from the sun to the earth in eight and one-half minutes. Its velocity must, consequently, be not far from a hundred and ninety-two thousand miles per second, or eleven and a half millions of miles per minute, or more than six hundred and ninety-one millions per hour; hence, a ball flying with the velocity of light around our globe would encircle it seven times and a fraction every second. Were such a ball illuminated, so immediately would the ball follow itself, so to speak, that its path would present a luminous, continuous, and permanent bow across the heavens.

It is by light that we see; and like as the nature and quality of the atmosphere are peculiarly adapted to breathing, so the nature

and quality of light entirely correspond to the eyes, and is completely fitted for perfect vision. Either a greater or less amount of light would have been a disadvantage, and would, doubtless, have been prejudicial to the eye and to general health.

And who shall ever portray the beauty, the essential excellence of light? Of what innumerable forms of happiness is it the immediate source! How does the whole habitable earth rejoice under its benign influence! In its bright presence how cheerily and pleasantly proceeds every business, every innocent amusement, every lawful pleasure, every prosperous journey by land and sea, every pure and elegant study, every fair and upward progress! Bathed in light, how ^{well} is the face of friendship, the smiles of love, the glad and beautiful countenance of childhood, the graceful form of lovely woman, the sprightly bearing and aspect of joyous youth, and the venerable and dignified presence of old age!

So supremely excellent is light that inspiration uses the name as one of the epithets of God himself. "God is Light, and in him is no darkness at all." Also, the great Redeemer is


the Light of the world, a light to lighten the Gentiles. A sun and shield is God ; the Sun of righteousness ; and the great city of God will have no need of the sun, neither of the moon to shine in it, for the glory of God will lighten it, and the Lamb will be the light thereof.

Thus, also, light is used as the brilliant emblem of many an excellence in human affairs. All the knowledges are light ; and men of great intellectual attainments, and who use such attainments for the benefit of mankind, are great lights. Men, too, of eminent virtue are burning and shining lights—shining before men, and thus manifesting to the world the glory of God.



LVII.

Color.

FROM light came Colors. Color being a simple idea is incapable of definition, and, like other simple ideas, needs none. The word *red* conveys as clear a notion of the color designated as any definition could convey of something else. con

The primary colors of nature are seven in number, and by transmitting rays of sunlight through a triangular glass prism they may be partially separated from each other and thrown upon a screen. This beautiful object is called the *Solar Spectrum*, and the separation of the different colors is owing to the different degrees by which they are refracted or bent upward in passing through the prism. The red rays being bent the least, appear, of course, at

the bottom of the spectrum or image upon the screen, and the violet being bent the most, appear at the top. Thus the order of the colors forming the spectrum, commencing at the bottom, is red, orange, yellow, green, blue (light), blue (dark), and violet. The rainbow is a solar spectrum in nature, formed by the sun's rays passing through a shower instead of a prism, and thrown upon the opposite clouds for a screen, and if the rainbow is perfect, as it sometimes is, all the seven colors may be clearly discerned. In the spectrum the change between any two colors is not abrupt, but the transition is gradual from one hue to another, so that the different colored rays and variations of them are, in fact, innumerable. Thus we have all shades of color, some of them having distinct names, and many others to which no specific name is applied.

Color, then, is not a quality or property of objects in nature or art, but is a matter of light simply, and hence, when light is withdrawn from them, they have no longer any color, but blackness enshrouds them all indiscriminately. Nothing is red, or yellow, or green, essentially, but these different aspects

come entirely from light, and the color of an object depends upon the rays of light which it most fully reflects to the eye. A red rose and white rose are the same and undistinguishable in a dark room. Admit the light and one of them is red because it reflects to the eye the red rays of light and absorbs the others. The white rose is white because it absorbs almost none of the rays of any color, but reflects them nearly or quite all to the eye, and thus appears of the color, so to speak, of light itself. So the sky is blue, as we say, not that there is any sky, or, if there were, that it is blue, but because the atmosphere, as we look up into it, reflects to our eyes the blue rays of light instead of others. Coal is black because, as we look at it, it reflects to the eye but few rays of light, but absorbs nearly all of them.

Now, why it is that some roses reflect to our eyes red rays and absorb the rest, that an orange reflects to us yellowish rays and absorbs the rest, that grass reflects the green rays and absorbs the others, and so of the whole? These are among the questions that human sagacity fails to answer. All, I think, that we can say is that they were divinely

constituted so ; a certain unknown permanent quality or qualities being enstamped upon all material objects, by virtue of which they reflect to our eyes one class of rays instead of others, while these others are absorbed and unseen.

And here, also, is another of the wonderfully benevolent arrangements. Beautiful, indeed, and ever glorious is light, as we have faintly portrayed, but what would even light be to us were all material objects so constructed as to reflect to our eyes all the light that falls upon them, or to reflect none of this light, or to reflect only one of the seven primary hues ? Then, in the first case, an undistinguishable and sickening whiteness would overspread the world, or, in the second case, a universal blackness would enshroud all nature, or, in the third case, a world of unvaried and permanent green, or red, or blue would be spread out before us ; in other words, such a sad arrangement would be equivalent to condemning man and beast to universal blindness. Light thus arranged, and we constituted as we are, "having eyes we should see not," an interminable and ghastly blank would be ever before us ; nor would it

matter whether it were white or black, green or red, and these eyes of ours, so skillfully and curiously wrought, might as well be changed to stones.

How different from all this is the actual arrangement! What a world of transcendent beauty bursts upon us from this divine contrivance of colors, and this corresponding contrivance whereby different objects reflect to our vision the different colors, and this marvelous capacity of the eye, also divine, by which we can distinguish not only the primary and more obvious hues, but those numberless and nameless slighted shades constantly passing before us amid the multitudinous walks and pursuits of human life! Thus, what a world of glory, did we but know it, is ever opened up before us! amid what a scene of enchantment are we ever moving, and breathing, and contemplating, and expatiating! Colors! Daughters of light! Fountains of beauty and of life-long and unspeakable delight! Sources of glorious art, and lovely almoners of nature's resplendent, magnificent garniture! One of the excellent gifts of an infinitely excellent God!

LVIII.

Sound.



WHEN you speak of *light* and *colors*, you speak of what is entirely external to sensation. But in speaking of *Sound* it is not precisely so, for though sound seems to be outside of us as truly as light, yet, in reality, it is otherwise.

Sound has been described as a sensation produced in the mind by vibrations of the air beating upon the drum of the ear. This affection of the tympanum or drum of the ear is communicated to the auditory nerve, and the sensation or sound ensues.

If such a theory is true, as I suppose it is, then a sensitive ear and vibrations of the air in contact with it are indispensable to sound. Were there an ear ever so perfect and sensitive,

without the vibrations of the air upon it there would be no sound, and, on the other hand, were there ever so many, and ever so violent agitations of the air with no ear for them to touch, there would equally be no sound. The simultaneous crashing of a thousand thunders would go out in perfect and absolute silence.

Wonderfully various and numerous are the sounds or voices of nature around us. It is curious that scarcely a moment passes us unaccompanied by some sound. The apartment where I am now writing is one of the stillest, and it is one of nature's quiet hours, yet the voices of whispering breezes are breaking through the lattice—notes of distant music are floating on the air. I mark the indistinct sounds of a car-bell as some train is just issuing from the depot, and bird-notes are here and there amid the listening tree-tops, while some indefinite and ceaseless murmur is abroad. I awake in the dark and stilly night and listen. Even now the silence is never perfect, nor is the world ever entirely asleep and still. Were any of us to note such a moment, it would be to us one of the strangest of our experiences ;

and, doubtless, we should hasten to disturb the unearthly and awful stillness.

Sound is not instantaneous, but travels from the sounding object to the ear at the rate of a little more than 1,100 feet in a second. Hence, when the sounding object is at a distance and yet in sight, the sound is a little after the sight. Thus, if you glance at a distant woodman as he swings his ax, you will observe that the ax falls a moment before you hear its stroke. So distant thunder is heard some time after you see the lightning. Thus by counting the seconds between seeing the lightning and hearing the thunder, and multiplying the number by 1,100, you have the distance in feet of the thunder-cloud. Were there to be a visible and audible thunder-shower at the moon, at six o'clock in the morning, we should hear the thunder at seven o'clock in the evening of the same day—thirteen hours after the sound started from the moon. Or should there transpire at the sun, at New Year, some great convulsion, whose report could travel to the earth, it would reach us on the 5th of the following August.

The variety of sounds which the ear is

capable of hearing, while it is limited, is yet extremely great. Take a single sound ; you can imagine that such a sound may have hundreds of degrees of loudness, all of which the ear is competent to hear. Then take each one of these sounds of different loudness, and to each one of them you may assign a multitude of different *keys*—descending with each one to the profoundest bass, and ascending to the intensest imaginable sharpness, and all within the ear's capacity to hear and endure.

And then consider how few, comparatively, of the countless sounds we hear are positively disagreeable. Nature's voices, especially, are, almost all of them, pleasant voices. It is true, there is the thunder-crash, the whirlwind and tornado, the earthquake rumblings, and some others ; yet some of these, but for associated ideas of danger and calamity, would not be unwelcome. But listen to the more common and ordinary breathings ; those sprightly and varied notes of a thousand feathered tribes ; those songs of the winds, now gentle and sweet as shepherds' lutes, now grand and glorious as the chorus of a thousand organs ; the deep and solemn voice of the ocean as it

rolls forth its "everlasting bass in nature's anthem;" the soft rustling of ripening and gorgeous harvests waving afar; the gentle murmuring of brooks and rivulets gliding along their winding way; the sweet lisplings of lake or river as their limpid wavelets kiss the sunny shores; the voices of love and goodness breathing amid myriads of happy homes; the shouts of joyous childhood mingling with the blithesome morning breeze; and last, but not least, the worship of the "great and goodly fellowship," going out in glorious song as the sound of many waters—the opening notes of the grand chorus of immortality.

It is true, the sounds that come to us are not all harmonious and pure. More or less of discord is abroad, and there are notes and voices that grate harshly and sadly upon the ear. There is evil with the good—cursings mingle with the blessings. But beware, my child, that thou blame not the God of nature, from whom comes naught but eternal harmony.

Atmosphere. (1.)



SO many of the topics thus far discussed are intimately related to the atmosphere, it seems to be time that I invite your attention to so important a theme.

This word—*Atmosphere*—comes from two Greek words—*atmos*, meaning *vapor*, and *sphaira*, meaning *sphere*. A *sphere of vapor*, then, is the atmosphere, and it envelops the earth as a garment.

The atmosphere, or air, is a fluid substance, composed mainly by the mixture of two gases, oxygen and nitrogen. There is also in the composition a slight quantity of aqueous or watery vapor, and a slighter quantity still of carbonic acid gas. If you divide a quantity of ordinary air into one hundred parts, there will

be by weight, and nearly by measure, of *nitrogen*, a little more than $75\frac{1}{2}$ parts ; *oxygen*, about $23\frac{1}{3}$ parts ; aqueous vapor, about one part, and of carbonic acid, one-tenth of one part.

Such is almost exactly the air we inhale from the first moment after our birth till we cease to breathe at death.

And right here, my young friends, let us pause, for a moment, and wonder and adore. These four ingredients composing the atmosphere, and the proportion of each one, are exactly right, and exactly adapted to the constitution of man and of the lower animals. Any variation, though slight, of the proportions, as above specified, would prove injurious to us ; any considerable variation would render the air unfit to breathe, and would prove fatal. Diminish, for example, the nitrogen, and increase the oxygen, and the wheels of life would begin at once to revolve too rapidly, and vitality would be expanded prematurely, and we should be hurried onward toward death. On the other hand, diminish the oxygen, and languor, weariness, and lifelessness would ensue, and disease would soon finish us. Remove the aqueous vapor, and much of the grateful

freshness of the atmosphere would be gone, attended, doubtless, by one and another evil consequence. Increase the carbonic acid from one-tenth of one per cent. to five or six per cent. and you have rendered the air unfit to breathe. Substitute for one-tenth of one per cent. of carbonic *acid*, one whole per cent. of carbonic *oxide*, which combines one atom of oxygen instead of two with one atom of carbon, and our breathing would at once poison us to death. In a word, make any alteration of the air whatever, whether of elements or proportions of elements, and you have altered it for the worse. Just as the atmosphere is, it is the best possible ; and every time we inhale it, at every breath we draw, we should breathe out gratitude, love, and worship to Him who has formed for us this among thousands of other admirable adaptations. So absolutely perfect is this fitness that in favorable circumstances we breathe, during all the day, with entire ease, as if inhaling the very spirit of peace and happiness, as well as of health and life.

As a further illustration, let me state that a person, breathing in the ordinary atmosphere, inhales a very different air from that which, at

the next moment, he breathes out from his lungs. He breathes in the pure air, air having its one-tenth of one per cent. of carbonic acid. But he breathes out an atmosphere charged with $4\frac{1}{2}$ per cent. of this acid. But off goes the breath into the boundless atmosphere, and, at the next inhaling, he draws in the pure air again, and all is well.

Let this same person, however, go into a crowded assembly of people. All are breathing, of course; and from a thousand breaths are borne out, every moment, an atmosphere, loaded with at least $4\frac{1}{2}$ per cent. of carbonic acid gas. Meanwhile, the space is limited and confined, and ventilation is neglected, and the air of the apartment is becoming more and more impregnated with the poisonous gas, while the oxygen is, every moment, diminishing. Distress, of course, ensues, breathing is labored and unrefreshing. It is not so bad as to be under water, or even to be enveloped in a dense and suffocating smoke, and yet there is a partial suffocation. *The air is changed.* It is not the blessed, native air. It is not the air that God has made; a poisonous element has entered, in frightful quantities, ~~into its~~

~~entered in frightful quantities~~, into its composition. Another element—the element of life itself—has alarmingly diminished. We are out of our natural element; pain is upon us; disease is hard by; and death is just beyond. Let us up and away! How good! how perfect! how like the very breath of life, when this man issues forth again into the atmosphere that the Divine Hand fashioned, compounded, and fitted for him!

You may have read the tragic story of the “Black Hole” at Calcutta, in India. If not, indulge this slight sketch: On the capture of the city from the British in 1756, *Surajah Dowlah*, the Indian nabob, ordered the British garrison of one hundred and forty-six men to be confined in the dungeon of the fortress—a room about eighteen feet square. There were but two windows, both upon one side of the room, and strongly barred, and admitting but little air from without. Into this one small apartment, on a hot night in June, all the hundred and forty-six men were crowded. So thickly they stood that the door was with difficulty closed upon them. In a few moments they were all in a perfect perspiration—then

came on raging thirst, and such was their agony that they strove to provoke the guards outside to fire in upon them and kill them. By nine o'clock in the evening several were dead, and as the night advanced all self-control was lost. Those in remote parts of the room struggled to reach the windows, and a dreadful tumult ensued, in which many were trampled to death. They raved, fought, prayed, blasphemed, and many fell exhausted to the floor, where suffocation came to their relief. Meanwhile the odor filling the dungeon was most deadly, and every moment became more so, and toward midnight the poor victims began to drop off in rapid succession. At six in the morning, when the door was ordered to be opened, only twenty-three out of the hundred and forty-six were alive, and these were either stupefied or raving.

The Indian tyrant had withdrawn from these poor prisoners the vital air, and they perished.



LX.

Atmosphere, (2.)



OF the four elements composing the atmosphere, oxygen is the positive and capital one. Nitrogen seems designed to serve as a sort of mollifier for restraining the too active influence of the fiery oxygen, like as water is mingled with spirits to reduce and temper their strength and energy. It is, of itself, utterly devoid of life-giving energy, and were the oxygen withdrawn from it, breathing would be as completely impossible as in a vacuum.

The presence of the aqueous element is seen by placing a pitcher of cold water upon the table in a warm room. The warm air coming in contact with the vessel is cooled, and thus its capacity for holding water is

diminished, and the water settles as fine dew upon the outside surface of the pitcher. It is, in fact, dew, this being, as we have already noticed, nothing more or less than the visible moisture deposited by the air upon a surface cooler than itself.

As in the composition of the atmosphere carbonic acid gas bears so small a part, being by weight only one-thousandth of the whole, and as air that is breathed comes back from the lungs loaded with $4\frac{1}{2}$ per cent. of this same gas, some of you may be led to ask, when so much carbonic acid is continually going out into the atmosphere from men and animals, and from age to age, why it does not increase and become, in time, a larger element of the atmosphere, and even so large as to become destructive. Such an inquiry is rational; and here is suggested to my young readers another of the Divine arrangements as admirable as it is wonderful, and which may well excite emotions of lofty praise and worship. There seems no reason why the disastrous influence alluded to should not transpire and even progress indefinitely until the whole animal creation were destroyed, but for the simple and

Divine compensation that has been established. This compensation is thus : While the animal world, in respiration, consumes oxygen and dismisses carbon into the atmosphere, the vegetable world, in the presence of sunshine, lives by precisely the reverse process ; for respiration, though different from that of animals, belongs to vegetables also, and these, as they respire in the day-time, consume carbon and dismiss oxygen to the air, and thus the life-giving element is perpetually renewed, while the life-destroying element is perpetually repressed. The universal animal breathing tends to annihilate all the oxygen of the atmosphere, and fatally poison this atmosphere with carbon ; but the universal vegetable breath catches up and hides away the carbon, and replaces the lost oxygen.



Atmosphere. (3.)



THE atmosphere enveloping this great globe is immensely abundant. Over all the earth there is no lack, and nowhere in open space is there a thought of any scarcity of the "vital element." By careful calculation it is estimated that it extends upward about forty-five miles above the earth. The region of air near the earth has, of course, the greatest density, being pressed upon by the weight of all above, like as when several fleeces of wool are spread one upon another the lowest fleece becomes the most flattened and solid, while the upper one remains in its natural condition. Thus the atmosphere, also, grows lighter and thinner as you ascend through it, until, at the height of about four

miles, it becomes insufficient for breathing, and respiration is difficult. Meanwhile, at such a great height, the ordinary air within the person not meeting sufficient pressure from without, expands and causes the system to swell painfully, and sometimes produces eruption of blood-vessels and other injurious effects. And were it possible to ascend eight or ten miles above the earth it is quite certain that the atmosphere there would be inadequate to sustain life.

Here, then, is another of the excellent adaptations, showing the hand of a wise and benevolent Creator. As the air in its *composition* is exactly right, so, also, in its degree of density upon the earth's plains it is precisely adapted to respiration. We were not designed to dwell on the summits of lofty mountains, but the "lower parts of the earth" are ordered for the habitations of men, and there the atmosphere is neither too dense on the one hand nor too light on the other, but its correspondence with the constitution of our lungs and entire system is perfect.

It is curious that this invisible medium that is all about us and within us, and which seems

so extremely thin and light, should yet be a veritable and material substance, and, taken as a body, of inconceivable weight as it rests down upon the solid earth. The weight of a column of air resting upon a square inch of the earth's surface, and extending up through the whole depth of forty-five miles, is fifteen pounds ; hence, the pressure being the same in all directions, downward, upward, and laterally, the entire weight of atmosphere pressing upon a man of ordinary size is about three tons. Such a pressure would, of course, be fatal to him were it not exactly counterbalanced by the air within, and by which every part of the person is pervaded and filled. And please not forget this one also of the innumerable Divine compensations.

Starting with this data of fifteen pounds of air on each square inch, you have only to practice a little arithmetic to ascertain the entire weight of the atmosphere as it rests upon the globe. Reduce to square inches the two hundred millions of square miles comprised in the earth's surface, multiply by fifteen and divide by two thousand, and you have the great result in tons ; or reduce one square mile to

square inches, multiply by two hundred millions, and that product by fifteen, and divide by two thousand. Your result will be, in tons, $60,137,344 \times 10^8$; that is, sixty millions, one hundred and thirty-seven thousand, three hundred and forty-four, multiplied by ten, raised to the eighth power, or 6,013,734,400,000,000 tons, a number which you may enumerate at your leisure. So true is it that the earth's atmosphere, considered as a mere substance, is no trifle, light and *airy* though it seem. Nor yet so very "light and airy" even the seeming. Its still, soft calms, its slight breezes whispering by us, are indeed ever so light and gentle. But when this great atmospheric world takes on one of its swift and mighty movements, and goes rushing, and roaring, and tearing over land and sea, hurling aloft men and trees, and houses and fences, and carrying devastation and ruin in its wild and terrible career, then we begin to realize that this invisible *something* above and around us is a "something" indeed, a reality, so to speak, with a vengeance!

The *elasticity* of the atmosphere is one of its deeply interesting qualities. To so remark-

able^a degree is it thus characterized that a portion of it has been known to expand to two thousand times its ordinary bulk. By its elastic energy it is ever ready to spring into every vacancy or vacuum. A beautiful instance of this is seen in the process of respiration. No sooner is the air inflating the lungs expired or breathed out and a vacuum created there than the air without springs in to fill up the vacant spaces. Thus, every moment we are enjoying the indispensable benefit of this quality of the atmosphere, and, perhaps, without a thought about it from morning to evening. A common air-pump—an instrument for exhausting the air from a vessel—will show you the operation of the elasticity of the air. Place under the glass receiver to be exhausted a collapsed bladder containing but little air, and then withdraw the air from the receiver, and the small quantity of air within the bladder will expand as the outside air is removed from it; then admit the air again to the receiver and the bladder collapses to its former condition by the expansion of the air around it. From the elasticity of the air comes its use for springs, air-beds, air-guns, and other things.

Climate.



THE term *Climate* is commonly understood as denoting the temperature of a place, its degree of heat and cold ; and the comparative climates of different localities of the earth present a subject of much interest to the curious student.

It is a general law touching climate, that the torrid zone, as noticed in a former sketch, comprises the warmest region of the globe, and the frigid zone the coldest, while from the former to the latter zone the temperature somewhat regularly diminishes. This may be said to be generally true, and it would be invariably and universally true were there not certain counteracting influences, which operate to disturb, in many localities, the regular gradation

of heat and cold in passing from the equator to the poles. At first thought it might seem that on the same line of latitude the climate would be the same all around the world; as, for example, Washington City and San Francisco being very nearly on the same line of latitude, some one might infer that the climate of the two cities is equally warm or cold. So of Quebec and Paris; so of the northern extremity of Newfoundland and the city of London; so of North Labrador and Stockholm. But a greater mistake could hardly be made than that the climates of these places respectively are alike or nearly so. So far is this from being the fact that the climate of Washington, at 39° , is about the same as that of Puget Sound, ten degrees further north; and the climate of Paris, at $48\frac{1}{2}^{\circ}$, is like that of Philadelphia at 40° ; and the climate of London, at $51\frac{1}{2}^{\circ}$, instead of being like that of northern Newfoundland, though of the same latitude, nearly corresponds with that of Richmond, Va., at $37\frac{1}{2}^{\circ}$; and the temperature of Stockholm, at 59° , instead of being similar to northern Labrador in the same latitude, is not very different from that of Bangor, Maine, at 44° .

If now you ask, as you certainly will, How does this happen? the general answer must be that it is owing largely to the irregular distribution of land and water upon the globe. If the earth were all water and without any northern or southern currents, or if it were all land, a plain, uniform surface, without hills or depressions, in either event the climate on any given parallel of latitude would be the same the world around. This sameness actually exists, to a great extent, on the parallels of the far south—those parallels that encompass the globe without crossing any considerable land, as from the fortieth parallel downward. You will ask, then, how the intervention of land effects so great a difference of temperature in regions of the same latitude? Your atlases instruct you that the great continents of both hemispheres push up broadly toward and around the North Pole. More than three-fourths of North America, for example, lies north of the fiftieth parallel, and spreading itself thence toward the pole, hugs it, including Greenland, nearly half around. The entire extent of this immense region, including its frozen bays and inlets, together with the great


Arctic Ocean beyond, is, a great portion of the year, one vast realm of cold and desolation, mainly the domain of everlasting Winter. All across this bleak space of thousands of miles the north-west wind—one of our prevalent winds—sweeps over the eastern half of the United States. Hither is wafted the cold atmosphere of these northern regions, while, as it is borne onward, it meets with little to mollify the temperature with which it started on its long journey hitherward. It comes from realms of cold, it sweeps along other frosty realms as it comes, it reaches us a frosty Arctic atmosphere, spreading itself over our plains, and hills, and coasts, and essentially and permanently affecting the climate of our country. Thus it is with the eastern portion of the North American continent, and likewise with the corresponding portion of the Eastern or Asiatic continent. Both of these portions of the world are powerfully affected, as to their climate, by winds sweeping from cold regions of the earth, and traversing, as they come, intervening lands which are also cold.

Very different is it, on the other hand, with the countries which have the great oceans for

their western boundaries instead of a wide reach of cold and icy country. Such are Western Europe and our own Pacific coast. The winds that reach these countries from the west and north-west, instead of coming across wide realms of frost, sweep over extensive and open seas, which tend to moderate the temperature of the atmosphere moving over them. Moreover, warm ocean currents flowing northward from equatorial seas, and crossing the ocean, bear with them to those favored countries a milder atmosphere. Such is the famous Gulf Stream of the Atlantic, while late discoveries reveal a corresponding stream, one or more, coursing northward and eastward through the great Pacific, and reaching by its influence the Pacific States and territories. Such are, doubtless, the main causes operating to work so great a difference between our climate and that of corresponding latitudes on the opposite side of the Atlantic, and also the opposite Pacific shores.

LXIII.

Winds.

AVING written of the atmosphere and of climate, the subject of *Winds* is very naturally suggested, for wind, as you are aware, is nothing else than the atmosphere in a state of motion. Sometimes the atmosphere is still; we call this a *calm*. Sometimes there is a gentle movement of the air. This, though a wind, is more generally called a *breeze*. If this increases considerably, we call it a *wind*; if it increases very much, we speak of it as a *strong* wind, a *high* wind, or a *gale*. If it becomes intense, it is a *mighty wind*. The more gentle movements of the air, or what we call *breezes*, are generally agreeable, and often delightful. Nature then seems animated and sprightly, the spirit of

health seems moving along the air. If the temperature be high, the breathing of the atmosphere affords a cooling influence, while the music of waving foliage is grateful to the ear. And it is worthy of being remembered that this breezy condition of the atmosphere is the prevailing condition in most habitable countries of the world. Nearly all localities have their storm-winds—the more violent disturbances of the air above them. But these are rather the exceptions than the general order, and the normal condition of the atmosphere of the earth is one of comparative quiet.

This, too, is one of the arrangements flowing from the Divine benevolence and goodness; for the atmosphere, though invisible, and, for the most part, quiet, is yet a fearful element, and in its seasons of storm-fury is sometimes frightful and destructive beyond most other earthly agencies.

The air being an exceedingly thin and elastic fluid, is agitated and disturbed with the utmost ease, and thus the constant occurrence of breezes and winds is natural and inevitable. Two grand causes of atmospheric disturbances, or winds, are *heat* and *moisture*. Let

a portion of the atmosphere become heated above the temperature of the surrounding portions and disturbance ensues. The heated air tends, at once, to expand and ascend, and continues to ascend till, by the cooler air aloft, it is reduced to the same temperature. But if this heated air tends to ascend, the surrounding cooler air will equally tend to flow in to supply its place and restore the equilibrium. This drifting in of surrounding air is wind. You might naturally suppose that in the event named, the surrounding air would rush in equally from all directions; and this would be so if the condition of the atmosphere were entirely alike at all points of the compass around the heated region. But this might be or might not be. For some reason, or reasons, the drifting in of air from one direction might be with a much greater momentum than from any other, and this current would predominate over all others, and might sweep in not only to the heated region, but far beyond it in the same direction.

Moisture, as well as heat, is a cause of winds, and it is partly on this wise: As from the sea or lakes and rivers, and moist lands,

evaporation proceeds, and as the vapor, being lighter than air, rises, as smoke ascends, more or less air is borne upward with the vapor, and thus the airy equilibrium beneath is disturbed, and winds are the consequence. Sometimes the contrary process is a fact. Away in the upper air immense quantities of vapor are condensed by cold, and thus becoming heavier than the air, gradually settle toward the earth and press upon the underlying air, and again the equilibrium is disturbed, and the pressed air flows outward instead of inward—a wind in the opposite direction. In connection with this, it should be remembered that only a small disturbance of the airy equilibrium, whether by heat, or moisture, or both combined, is often sufficient to occasion a considerable wind.

The fact has already occurred to you that winds are *variable*. Sometimes they come from one point of the compass, and sometimes another. This variableness of the winds is specially characteristic of the temperate zones, while in the torrid and frigid zones there is more uniformity. In the torrid zone, for example, and in the neighborhood of the equator

is a region of heated and rarefied air extending around the world. In this equatorial belt the heated air is continually ascending into higher regions of the atmosphere, whence a portion of it floats northward, and another portion southward. To supply the place of this air at and near the equator, another portion of air starting from twenty-five to thirty degrees north and south latitude, drifts in toward the equator. The air from north of the equator approaches it in a south-west direction, and that from south of the equator in a north-west direction. These two winds are uniform, and are called *Trade-Winds*, from the assistance they afford to commerce—vessels sailing westward taking advantage of these whenever practicable. For such is the regularity of these winds that ships within their influence are enabled to sail thousands of miles, without altering their course or changing a sail.

This phenomenon of the regularity of the trade-winds would be the same entirely around the world but for a cause which I will now name to you. The torrid zone, in the Eastern hemisphere, includes large tracts of land as well as water. Under the torrid sun this land

THE WINDS AND THE SEAS.



becomes much more heated than the neighboring waters. South Hindostan, for instance, becomes a more heated region than the Arabian Sea or Indian Ocean. The consequence of this is that the regular current of the trade-winds is disturbed and a new wind-current is created opposite to the regular current. From the Indian Ocean a wind, instead of continuing uniformly toward south-west, sets in north-eastward toward the heated territory of Hindostan. Also, from the seas north of Australia, a current, instead of continuing north-west, the regular direction, drifts directly south-east and south, toward the heated region of that great island. These are the counter-winds that are called *Monsoons*, and are often frightfully violent and destructive.

The winds of the temperate zones, as we have already remarked, are variable, having no such regularity as those of the torrid zone. The prevailing winds, however, are westerly, the south-west and north-west winds being the more common winds of the north temperate zone. Easterly winds are frequent on and near the Atlantic coast, and are often attended with storms of rain in warm weather, and of

snow in the Winter season. The south-west wind, as you might expect, is a warm wind, and, if it continues for two or three days, is wont to be attended with rain. The north-west is a cool wind, and in this country, at least, is almost invariably attended with fair weather.



LXIV.

Whirlwinds.



WHIRLWINDS are winds whose course, instead of being direct, is circular or spiral. They differ extremely in the velocity and force of their motion. Sometimes they appear in the shape of a small and gentle eddy gliding by, and lifting light substances, as straws or dust, from the earth as they pass. For, in addition to their whirling motion, they have a progressive motion along the earth, sometimes moderate, and, at other times, of great swiftness. At times, they rush along the earth and around their axis with awful violence, carrying destruction in their path, which, in breadth, covers a space of from two or three hundred yards to as many miles. When their path is narrow they are

frequently called *Tornadoes*, from the Spanish word *tornar*, to return. The tornado appears suddenly under a clear sky, is of great violence, advances rapidly along the earth, and is of brief duration.

Another form of the whirlwind is that called *Cyclone*, which seems to be noticed mostly as traversing over seas. It does not, like the tornado, come down as out of a clear sky, but is said to set in during a protracted rain-storm, with a path from one hundred to five hundred or six hundred miles wide, and advancing along the ocean with a comparatively slow motion.

The name *Typhoon*, from the Greek *tuphon*, bears a meaning nearly similar to the term *cyclone*, although a wider signification is often given to the word, being used to express a violent or parching wind, though not a whirlwind.

Every form of a violent whirlwind is frightful and terrible in the highest degree. Few situations imaginable are more awful than to be in or near the center of the path of a tornado as it goes whirling and sweeping across the country. Its coming is sudden, and all at once the world grows dark, and there is a rushing, roaring sound, such as is never heard

elsewhere, and which is too terrible for description. A wind is raging such as might seem sufficient to sweep the world away. Before it nothing escapes. Trees are prostrated, houses are demolished, every fence is swept from the landscape, the darkened air is filled with various matters and things that are literally blown away, and the day of doom has already come to more than one precious life. It is but a brief moment and the great car of desolation and ruin is soon gone by. Such as have survived and find themselves uninjured, experience within themselves a momentary emotion of unutterable relief, and perhaps clap their hands for exceeding joy. But a scene of utter desolation is all about them. Every tree and dwelling is laid low, nothing is left as it was only ten minutes ago, and there are already heard the groans and cries of wounded and dying people. One and another are already dead, and others are missing, having been hurled into the air, and have fallen broken and, perhaps, lifeless somewhere. It is one of the frightful and heart-rending tragedies now and then occurring along life's checkered way.

Nor are all these terrible storm-winds so very unfrequent even in our own favored country, especially in the great Mississippi Valley. During the season of 1859 I counted as many as a dozen of these awful disturbances, several of which occurred in different parts of the State of Illinois; one passing eight or ten miles south of my residence, sweeping every thing before it, and destroying several lives. Shortly after, another rushed by and partly over me, giving me a moment's experience such as I never knew before, and such as I pray may never be repeated. If ever a dark and terrible ruin seemed imminent, it was during those few seconds. But it passed on, and with it went one of those moments of life, happily but few with the multitude, surcharged with unspeakable terror and alarm.

But the whirlwind, whether in the shape of the tornado or the cyclone, is not the only frightful and destructive wind. The *Sirocco* of the Mediterranean realms, and the *Simoon* of Syria, Arabia, and India, are also dreadful visitations; they are similar winds, blowing with great violence and for a considerable time, all charged with terrible heat, and exert a suffoca-

ting influence on men and animals, and a blasting effect upon the vegetable world over which they sweep. The sirocco is a south-east wind driving across the Mediterranean from African deserts. The simoon also comes from southern deserts, and, after blowing two or three days, becomes very fatal to life. People shut themselves up in their houses, and travelers over deserts keep within their tents, or dig for themselves pits in the sand, and thus hide away from the blasting storm, while the camels, for self-protection, instantly bury their noses in the sand.



Uses of Winds.



WE have seen that winds are sometimes terrible and disastrous, yet these instances are exceptions and not the general rule. The general rule is that they are *useful*. They are, indeed, indispensable. Doubtless, if we knew much more than we do, we should see that even these destructive winds, to which allusion has been made, have their beneficial as well as their injurious influences, and form a part of a great general plan of wise and benevolent operations always being wrought out under the hand of the great Father of all.

But if we can not see all this, let us turn our eyes toward what we can see and appreciate; and already have we alluded to some of

the benefits of winds. We have seen, for example, how that the Trade-Winds are greatly beneficial to commerce by enabling vessels in their vicinity, and which are bound westward, to avail themselves of their uniform and favorable breath, whereby they are borne on their course over the sea through days and nights without the shifting of a sail. Columbus drifted unwittingly within the influence of these favoring breezes as he sailed hitherward on his first voyage of discovery; and so regular was the westward impulse that the sailors, instead of welcoming its aid, became alarmed at the regularity of the winds which were so constantly driving them away from their homes and country, and feared that so unusual a phenomenon was but some dreadful and fatal breath bearing them on, by day and night, toward some unknown catastrophe, and which would effectually prevent them from ever retraversing those unknown and lonely seas.

Nor are the Trade-Winds the only winds serviceable to navigation. The variable winds are all of value to its great interests, and are all pressed into its service. "Head-Winds," it is true, must be encountered, and these often

impede the voyages of vessels upon the seas; yet what are head-winds to a thousand mariners are the favorable gales to a thousand others, who thus are borne swiftly on their way toward the "desired haven." And even head-winds, unless they are wild and mighty winds, are more welcome to the sailor than calms; for, though they compel him from his direct course, yet he knows the maneuverings and tactics by which to make even hostile winds contribute to his progress.

We have also alluded before to the refreshing and invigorating influence of the winds as they pass over us. What more irksome and wearisome, especially in Summer days, than the dead calm of the atmosphere? and in the midst of such a calm how animating, how inspiring, and welcome is the springing up of delicious breezes, wafting to us fresh drafts from out of the deep and inexhaustible cisterns above and beyond us! How cooling and reviving is that new-born breeze! How does it play around us, and lift us up as into a stronger and more earnest life! and how, from a scene of inertness and drowsy dullness, has it transformed all nature into music,

sprightliness, and loveliness ! Who would wish to live if life must be endured under the dominion of an unending calm ? No gentle fanning upon the brow of toil ; the stillness of death in all the vast, deep firmament ; no leaf stirred, if leaf could be ; no joyous billow tumbling ashore ; no ripple on the glassy lake ; no waving meadow lands or harvest fields ; no whisper among the still and mourning trees— one wide, still, dead world, from the crown of the head upward and forever !

And if winds are often cooling and refreshing amid Summer heats, so they are as often warming and enlivening amid Wintery and frosty days. Welcome, after successive days of cold and frost, is the drifting in of southern breezes, wafting to our Wintery latitude the *wintery* softer airs of more gentle climates ; and as they begin to breathe over the snowy and desolate landscape, how soon does Winter unloose his icy grip, and how promptly do the snows dissolve, and the streams and brooks begin to flow again !

Winds, too, are indispensable to the distribution of rain over the countries of the world. As evaporation proceeds from the surface of

seas, lakes, and rivers, winds are necessary to bear the new-formed clouds ashore, that they may shed their burden of waters upon the underlying land. But for winds to perform this great service the vapor and the clouds would remain suspended above the waters whence they originated, and upon these waters they would shed their useless rain, which would fall directly and perpetually back. The present magnificent circulating system of water would have no existence. Over the water would be incessant rains, and over the land incessant sunshine and drought. Not a cloud would ever float over us, not a rain-drop would ever fall on field or mountain. Of course, the world would be one vast and hideous desert, without an inhabitant, or tree, or a single green thing—as bare, and naked, and fruitless as the bald granite of the mountain ledge.

Also, winds have their uses as mechanical agencies, and that not only for the propulsion of vessels over seas, but for lifting water from wells, for draining purposes, for salt manufacture, as well as for other useful ends.

Great is their use, too, for the dissemination of various seeds, as thus from trees and other

plants where they originate they are borne through the air and scattered abroad in various directions, and sometimes to considerable distances. And many kinds of seeds are provided with certain appendages, by which they may with greater facility be thus wafted through the air, and lodge and take root in other localities.

Useful, also, are the winds as they sway hither and thither the trunks and limbs of trees, thus contributing to their firmness, strength, and beauty, and aiding in the circulation and activity of their juices and their healthy growth, as well as the excellence of their fruits and foliage.


Finally, the incessant movements of the atmosphere—movements sometimes violent and even terrible—are ever conducive to its preservation as a salubrious and healthy element. Various noxious substances and localities are scattered all along the earth, always affecting, more or less, the atmosphere coming in contact with them. Thus, were there an eternal calm and no circulation of the air, much of the earth, from this one source alone, would become unfit for habitation. But the winds are ever

interfering to prevent this poisoning of the atmosphere; sweeping away unhealthy portions, driving them aloft and over seas, and where their salubrity may be more or less restored, and replacing them with a purer and healthier medium.

Such are some of the uses of winds. Sometimes dreadful are they, and bear dire destruction on their swift and mighty wings; but, in the general, their breath is mild and healthy, and their touch is inspiriting and gladdening, and their movement graceful as when gentle billows roll onward over Summer seas, and their voice is Nature's grand and glorious harp, whose strains, now soft as infant breathings, now loud as many waters, are ever wafted to the listening ear, and waking glorious music to enchant the world.



Rain-Storms.



INTIMATELY associated with winds and the atmosphere are the *Storms* so frequently occurring in most regions of the earth. We have before alluded to those terrible *wind-storms*, which, under the name of *whirlwinds*, *tornadoes*, etc., not unfrequently take their wild and destructive path over land and sea. We now write of those ordinary storms—storms of rain, which are common in the temperate zones.

Happily, it is not all "fair weather." Often, indeed, there are several days of uninterrupted sunshine. No cloud, even of the "bigness of a man's hand," is seen upon the deep-blue sky. Mellow breezes glide over the plains, and whisper amid the trees. The genial air is vocal

with bird-notes. The cattle are abroad upon a thousand hills. Men and women are intent upon business or pleasure, and there is the seeming of a world that, in its quietness and permanence, never knew storm or change; yet we awake on some morning, and looking through the lattice we perceive that it is no longer "a morning without clouds." On the contrary, they are gathering densely and darkly. Sun and sky are utterly hidden. A different wind from that of yesterday is drifting in—a damp, raw, and chilly wind, as if it came from some cold Atlantic depths. An entirely different hue and aspect are enstamped upon the world. Another scene spreads itself away before us and around us; another sound and voice are in the air.

"Along the hills, along the moorish fens,
Sighs the sad genius of the coming storm!"

Meanwhile the cloudy canopy thickens and darkens, and the air dampens and grows murky and moist. And then, anon, a fine mist is falling, which waxes shortly into a steady and determined rain; and gazing off hither and thither to the farthest horizon there

seems to be rain every-where. The wide world, yesterday so sunny and bright, blue above and radiant and brilliant beneath, is now turned into a world of rain, and warm airs are changed into such as are chilly and cheerless. I am looking now out upon such a storm. All "out-of-doors" is wet and somber. Overhead is one vast, dark, and unbroken cloud, covering all the welkin. It seems to have taken the place of the beautiful, blue sky, and has the look of intending to remain up there, as if it were hereafter to be the normal condition of the firmament; for who can push aside the enormous mass that it should not hover over us forever?

And so it rains, rains! All over those distant hills and woods there is naught but rain and gloom, and, near by, the roofs are all dripping, and the smoke issues slowly and sluggishly from the chimney-tops and hangs near the roofs, as if it dreaded to ascend into the dismal world of descending rain; or else it is hard going up against such a tide; or else it may be that the air is too dull and sluggish to bear it upward. Only one bird is abroad, and there he is, poor little fellow, tugging, and

turning, and fussing away up there in the rain, and seems hardly to know what he would better do or what course to pursue.

There is no wind. The rain falls vertically down; falls steadily and yet leisurely, as if there were an abundance of opportunity, and as if it had proposed to take its own time. And men with dripping umbrellas are hurrying along the wet sidewalk to their business places; and there goes, with light, elastic step, one of the tenderer sex, whom industry and, perchance, necessity drives daily through storms as well as sunshine to some distant task.

Such is the rain-storm. It may last through the day or through several days. It will doubtless continue so long as the east or north-east wind continues. When, by some means, the wind veers round to the north-west the great cloud ocean overhead will soon be broken up, and the vapory fragments will be borne away eastward, and the blue sky and glorious sun will reappear, and the world will smile once more.

Thunder-Storms.



THE thunder-storm is another variety of storm from that described in my preceding sketch. It comes on more rapidly and suddenly—is usually more violent—is often immediately preceded as well as accompanied by wind; it is, also, attended with lightning and thunder, and is of brief duration. It is more usually termed a *Shower*; and is rare in the Winter season, but very common in connection with the heats of Summer.

Their approach is marked and regular, and where occurring in the day-time are more common in the after part of the day. Not long after noon, bright, rounded clouds are seen lying off in the west and north-west.

These, in fact, often show themselves in the morning hours, and, by the farmers, who, in the haying season, watch them carefully, are called "thunder-heads," as being often fore-runners of a coming shower. At length, stretched along beneath these "thunder-heads" and bordering the whole western horizon, is seen a dark, unbroken cloud, having a hue like that of the deep-blue ocean. This is a sure presage of a thunder-shower. If is, in fact, such a shower already commenced, and falling fast away twenty or thirty miles west of the beholder. Simultaneously with the appearance of that low, deep cloud is heard the rumbling of the distant thunder. In a little time the narrow cloud has widened and lifted itself up a number of degrees higher above the horizon. It stretches itself now from north to south, covering with blackness all the western sky. All along the upper border is ruffled with broken clouds, angry and dark, while beneath these, down to the horizon, hangs the essential blackness—the awful storm-cloud itself, and ever and anon forked lightnings of ineffable brightness are playing over its surface, attended by thunderings,

now grown prompt, distinct, and awful. Still towers up more and more the immense cloud, and presently the air, thus far, perhaps, quiet and silent, becomes disturbed. A roaring, rushing sound is suddenly heard abroad, and a strong wind, as if poured directly down from those dark and overhanging border clouds, bursts upon the landscape, and the trees sway fearfully hither and thither under the mighty blast. The underlying world has assumed now the hue of the great cloud-ocean lying aloft. Turning the eye westward, the great shower is seen falling thick and fast within a mile or half a mile away, and you can distinctly hear the roaring sound as it is pouring upon the earth. Instantly a few great drops fall where you are. Now fly to the nearest shelter, or in a minute more the drenching tempest will be right upon you! And here it is; and the rain is as if the gates that let down the ancient flood were again opened, and the world, for the time being, is a world of waters, while the accompanying lightnings and thunder-crashes are as if the day of doom were breaking upon the trembling earth.

This, or something like this, is the thunder-

storm ; one of the sublimest and most awful exhibitions which this world presents—nor is it without its dangers and its disasters. More or less, every Summer season, are smitten and killed by the lightning stroke as it falls, here and there, from the surcharged atmosphere. Buildings, also, are, of course, subject to the destructive blow, and, in many an instance, are wrecked and ruined by it, while tall forest trees often attract to themselves the fatal flash and are literally shivered into a thousand pieces.

Like the earthquake and tornado, the thunder-tempest has an angry look, and its voice is a voice of terror, and its touch is often destruction and death. Why some of God's providential dispensations and arrangements are thus dark and dreadful, we may not, at present, fully understand. One thing should be ever kept in mind as an established certainty, and that is, that this world is not designed as a final home and resting-place ; that while the bright side of our earthly existence is ample and beautiful, yet there is a gloomy side withal. It is a sinful and erring world, and sin is the parent of wretchedness

and death ; and we are all of us involved, "for all have sinned."

Whoever of us, therefore, looks for perpetual sunshine in this earthly life will very certainly be disappointed. There will be many comforts and much happiness, but trembling and sorrow are in store for us, and there is no other true and safe way than to secure an early interest in the great salvation of Christ.

"Remember now thy Creator in the days of thy youth, while the evil days come not, and the years draw nigh when thou shalt say, I have no pleasure in them."

"If a man live many years, and rejoice in them all, yet let him remember the days of darkness, for they shall be many."



Snow-Storms.



F the rain-storm and the thunder-storm I have already written. In Winter-time, and in our northern latitudes, the watery vapor becomes frozen in the air, and descends in the form of *snow*; and covers the earth to a depth of several inches, or sometimes two or three feet.

The snow-storm, like that of rain, may continue for a day, or for two or three days; and, like the rain-storm, it may be quiet, or accompanied with a strong wind, driving the snow horizontally through the air, and heaping it up in drifts. Also, like the rain-storm, it gives out unmistakable tokens of its coming, which tokens, together with the storm itself, and some of its accompaniments, have been so

graphically and truthfully pictured to us by Whittier.

"The sun, that brief December day,
Rose cheerless over hills of gray,
And, darkly circled, gave, at noon,
A sadder light than waning moon.
Slow tracing down the thickened sky
Its mute and ominous prophecy,
A portent seeming less than threat,
It sank from sight before it set.
A chill no coat, however stout
Of homespun stuff, could quite shut out,
A hard, dull, bitterness of cold
That checked, mid-vein, the circling race
Of life-blood in the sharpened face,
The coming of the snow-storm told.
The wind blew east ; we heard the roar
Of ocean on his Wintery shore,
And felt the strong pulse, throbbing there,
Beat with low rhythm our inland air.

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Unwarmed by any sunset light,
The great day darkened into night,
A night made hoary with the swarm
And whirl-dance of the blinding storm,
As zig-zag wavering to and fro,
Crossed and re-crossed the winged snow ;
And ere the early bed-time came,
The white drift piled the window frame,
And through the glass the clothes-line posts
Looked in like tall and sheeted ghosts.

So all night long the storm roared on ;
The morning broke without a sun ;
In tiny spherule traced with lines

Of nature's geometric signs,
In starry flake and pellicle,
All day the hoary meteor fell ;
And when the second morning shone
We looked upon a world unknown,
On nothing we could call our own.
Around the glistening wonder bent
The blue walls of the firmament ;
No cloud above, no earth below,
A universe of sky and snow !”

Snow-storms occur on our continent from thirty degrees northward ; but south of forty degrees the snow rarely lies throughout the Wintery season. North of forty degrees it is more permanent, and commonly covers the ground through the Winter ; while, sometimes, the snow, falling before the earth is much frozen, covers it deeply over, and shelters it from further frosts. Thus the roots of grass and grain, and other roots, are protected and benefited ; while, often, in more southern latitudes these roots are often killed, or much injured. So, also, the permanent Winter snows are favorable to traveling, and to business communications, forming, as they do, foundations for smooth roads, over which sleighs glide, and heavy loads are transported with speed and facility.

Animal Creation.

THE earth is inhabited. It was designed to be the abode of life and enjoyment. What would be works merely *material*, however beautiful or grand? What would be a vast world like ours with not a solitary specimen of life upon its surface, or in the air above, or in the depths beneath?

Such, indeed, is one of the Mosaic pictures. At the end of the fourth day land and water were separated, the green herbage had carpeted the landscapes of the world, the forests were abroad in their stately magnificence and beauty, and fruit-trees—every one that was “pleasant to the eye and good for food.” Moreover, the sun and moon were in their places, and the great, glorious world was finished—finished as

truly as Solomon's gorgeous Temple, or the towering Pyramids, or the grand Coliseum were ever finished.

nity The world was finished and waiting. But what a variety and a failure if the fourth day's work of creation had been the last day! A great and superb theater fitted up for nothing! A brilliant paradise of far extent doomed to eternal vacuity and nothingness! A world of lovely fruits, and every rich variety thereof, with no eye to see them, no lips to taste them! A glorious instrument, holding within itself music that might charm a listening universe, yet whose keys must remain untouched, and no enchanting note awake from it to break the everlasting silence!

Not such was the Creator's order—not such his wisdom. When the material work was finished the *Life* was at once ushered in. When the dwelling-place was ready, then were the dwellers introduced. When all excellent provisions were made, then came the varied capacities for enjoying them perfectly. And when the six days' work was completed, the fowls were flying above the earth in the open firmament of heaven, the fish of the sea were



THE ANIMAL CREATION.

rejoicing in their native element, the cattle and creeping things, and beasts of the field, were abroad, and man, the crowning life of earth, was walking in majesty and beauty amid the new-created scene.

So life came—came directly from its great Author, came promptly, came in myriads of shapes and forms, came with the capacity and high command to communicate itself; and thus this great earth was peopled. Nor of all the phenomena glanced at in this series of sketches is there any thing pertaining to our globe at all comparable to the phenomena appertaining to its magnificent system of life. Whether we contemplate its mysterious nature, its multiplicity of forms and species, its countless diversity of shapes, its infinitude of individuals, or its comprehensive capacity for enjoyment, all is marvelous in the extreme.

Linger for a moment with one or two of these points. Contemplate, for example, the amazing diversity of shape and dimensions which life, on this earth, assumes. Contrast the whale, a hundred feet long and weighing a hundred tons, with the animalcule, 30,000 of which may inhabit a single drop of water, and


35,000,000,000,000,000,000 of which would be requisite to weigh down the said whale.

You and I are acquainted with a number of animal species; but we must needs become familiar with as many as 300,000 species before we shall have examined them all, and as many as 100,000 of these species or kinds we must examine with a microscope in order to see them.

Then glance at the enormous multiplication of life, especially as connected with one or two species of the animal world. The codfish annually produces more than 9,000,000 of eggs, and the sturgeon more than 7,000,000. So, also, mackerel and herrings multiply by millions. They often rush in shoals miles in length; so thickly they swarm along, that a boat can make no headway through them. More than half a million herrings have been taken in a night by a single boat. Even of cod, a much larger fish, it is computed that the average quantity caught annually can not be less than 250,000,000.

“He openeth His hands, and supplyeth the wants of every living thing.”

Valedictory.

Y YOUNG FRIENDS,—Our rambles are finished. I can not but hope that some of you—though the number may be limited—have consented to walk, and look, and meditate with me. If so, it is certainly a most interesting path that we have traveled, however inadequate and imperfect may have been the views we have taken of this great world and its appurtenances. We have traversed land and sea, and roamed amid mountains and along far-reaching plains, and sat down beside great rivers, and lingered, also, with their distant and secret sources. We have hovered near the frozen poles, and winged our way to torrid realms, and have listened to the awful voices of dire earthquakes and volcanic thunders, and felt the dismal, frightful rush of the whirlwind storm.

Yet were these mainly but exceptional features ; and we noted, in our roamings, that this great round world is, after all, adorned with multitudinous beauties, and is so made and arranged as to be the fit abode of millions on millions of happy intelligences. A few of its luminous and beneficent aspects and providential adaptations we saw and admired, a mere specimen or two of a whole world of divine perfections arrayed in colors of "living light" to the open and purified vision.

Was it not pleasant to sojourn in many of this earth's sunny lands and repose amid fragrant groves, and commune with each other on sunny eminences and along quiet shores, and mark, in our progress, every affluence of pleasant fruits, and glorious harvest-fields, and fair abodes, and herds abroad upon a thousand hills, and "light-winged" commerce gliding over every sea ; a vast arena of magnificence and splendor indescribable, and a brilliant stepping-stone, if its dwellers so ordain, to the heavenly paradise beyond !

Right here, my young friends, you and I part company ; yet we need not be separated from Nature's resplendent and royal associa-

tions, nor wander, for a single hour, from those peaceful and holy paths where God himself is walking and energizing. There, if we please, we shall feel the inspiration of his breath upon us; and, if we listen, we shall hear him in the utterance of a thousand voices; and as we look, and look long and carefully, we shall discern, with a vision clearer than that of Elisha's servant, that the Earth is full of the glory of the Highest.

Adieu, dear children! And a great and good life be yours!

I remain, ever,

YOUR FRIEND AND SERVANT.



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